Appendix D

Institutional Control Plan

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Institutional Control Plan

for the

Naval Reactors Facility

Prepared for the
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EPA, Region 10, May 1999, "Region 10 Policy on the Use of Institutional Controls at Federal Facilities," Office of Environmental Cleanup, Office of Waste and Chemicals Management, and Office of Regional Counsel, Seattle, Washington.

WEC, 1992; *Sampling and Analysis Plan for Operable Unit 8-05 Track 2 Investigation Naval Reactors Facility, Idaho Falls, Idaho, August 1992.*

WEC, 1995; *The Remedial Design Report and Remedial Action Work Plan for the NRF Inactive Landfill Areas,* August 1995.

Acronyms

A1W	Large Ship Reactor Prototype (1st Aircraft Carrier design by Westinghouse)
BLM	Bureau of Land Management
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFA	Central Facilities Area
CFR	Code of Federal Regulations
DOE	Department of Energy
ECF	Expended Core Facility
EPA	Environmental Protection Agency
ESRP	Eastern Snake River Plain
FFA/CO	Federal Facility Agreement and Consent Orderheck other docs]
IC	Institutional Control
ICP	Institutional Control Plan
IDEQ	Idaho Department of Environmental Quality
IDHW	Idaho Department of Health and Welfare
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technological Center
IWD	Industrial Waste Ditch
MCL	Maximum Contaminant Level
NCP	National Oil and Hazardous Substances Contingency Plan
NPL	National Priorities List
NR	Naval Reactors
NRF	Naval Reactors Facility
O&M	Operation and Maintenance
OU	Operable Unit
RCRA	Resource Conservation and Recovery Act.
RI/FS	Remedial Investigation and Feasibility Study
ROD	Record of Decision
S1W	Submarine Thermal Reactor Prototype (1st Submarine design by Westinghouse)
S5G	Submarine Reactor Plant Prototype (5th Submarine design General Electric)
SL	Sewage Lagoon
SRP	Snake River Plain
SRPA	Snake River Plain Aquifer
TRA	Test Reactor Area
USGS	United States Geological Survey
WAG	Waste Area Group

Executive Summary

The United States Environmental Protection Agency (EPA) Region 10 has issued the final policy on the use of Institutional Controls at Federal facilities. The policy establishes the measures that ensure the short- and long-term effectiveness of Institutional Controls to protect human health and the environment. At the Naval Reactors Facility (NRF), managed by the U. S. Department of Energy - Naval Reactors (DOE/NR), Institutional Controls may include the following:

1) Visible access restrictions
    a) Warning signs
    b) Fences, barriers, or permanent markers
2) Procedures to control site activities:
    a) Bettis Site Development Plan
    b) OU 8-08 Areas Operation and Maintenance Plan
    c) OU 8-05/6 Landfill Operation and Maintenance Plan
    d) Public Notices
    e) Department of Energy Directives
    f) Site Radiological Controls Requirements
    g) Personnel Training
    h) Excavation Controls
3) Inspections
4) Unauthorized access safeguards
5) Published Surveyed Boundaries
6) Notice to affected stakeholders
7) Property lease and transfer regulatory requirements

1.0 Introduction/Purpose

During May 1999, the United States Environmental Protection Agency (EPA) Region 10 issued its final policy on the use of Institutional Controls (ICs) at Federal Facilities (EPA 1999). The policy established the measures that ensure the short- and long-term effectiveness of ICs that protect human health and the environment at Federal facilities undergoing remedial actions in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). This policy requires that an initial Institutional Control monitoring report on the status of the ICs be submitted to the Idaho Department of Environmental Quality (IDEQ) and the EPA six months following the signing of any decision documents. This policy also requires IC monitoring reports be submitted at least annually thereafter. The initial Naval Reactors Facility (NRF) IC Monitoring Report was issued to the State of Idaho and the EPA in February 2001.

NRF, which is located in the central portion of INEEL, has been designated as INEEL Waste Area Group (WAG) 8. This Institutional Control Plan (ICP) documents how NRF will implement ICs for the facility, to preserve the underlying assumptions of the Remedial Investigation/Feasibility Studies (RI/FS) developed for WAG 8. This ICP provides both inspection methodologies and overviews of standard site procedures that will be used by NRF personnel and contractors to institute and inspect the mandated ICs at WAG 8. The ICP delineates the controls necessary at each site while a work force is present at NRF in order to prevent unnecessary exposure to contaminants and to control potential disruption of the site (i.e., proper notification and approvals before removing fences, excavating in areas for future construction, etc.). In the event that there is no longer a government presence at NRF in the future, mechanisms are in place to assure that all ICs necessary to ensure protection of human health and the environment are in force (e.g., establishing necessary deed restrictions, and developing new mechanisms for public and stake holder notification). ICs at NRF will be applicable to all capped areas (including associated groundwater and soil gas monitoring wells) and to those areas classified as "No Further Action," since contaminants remain in these "controlled areas" that preclude their release for unrestricted future use at this time.

2.0 Background

2.1 INEEL Background

The INEEL is a government facility managed by the DOE, and is located approximately 35 miles west of Idaho Falls, Idaho. The INEEL encompasses an area of 890 square miles (mi^2) of the northeastern portion of the Eastern Snake River Plain (ESRP).

Facilities at the INEEL perform nuclear research, development, and waste management. They also have a mission to perform environmental research. Areas surrounding the INEEL are managed by the U. S. Bureau of Land Management (BLM), and are for multipurpose use. The developed areas within the INEEL are surrounded by a 500 mi^2 buffer zone used for cattle and sheep grazing. NRF is located near the center of the INEEL (see Figure D-1). Communities closest to NRF are Howe (7 miles northwest); Arco (20 miles west-southwest); and Atomic City (13 miles southeast). In the counties surrounding the INEEL, approximately 45% of the land area is used for agricultural purposes, 45% is open land, and the rest is urban. Sheep, cattle, hogs, poultry, and dairy products are produced; potatoes, sugar beets, wheat, barley, oats, hay, and other seed crops are the predominant agricultural products of the area. Most of the land surrounding the INEEL is owned by private individuals or the U.S. Government. The rest is either state or corporate property.

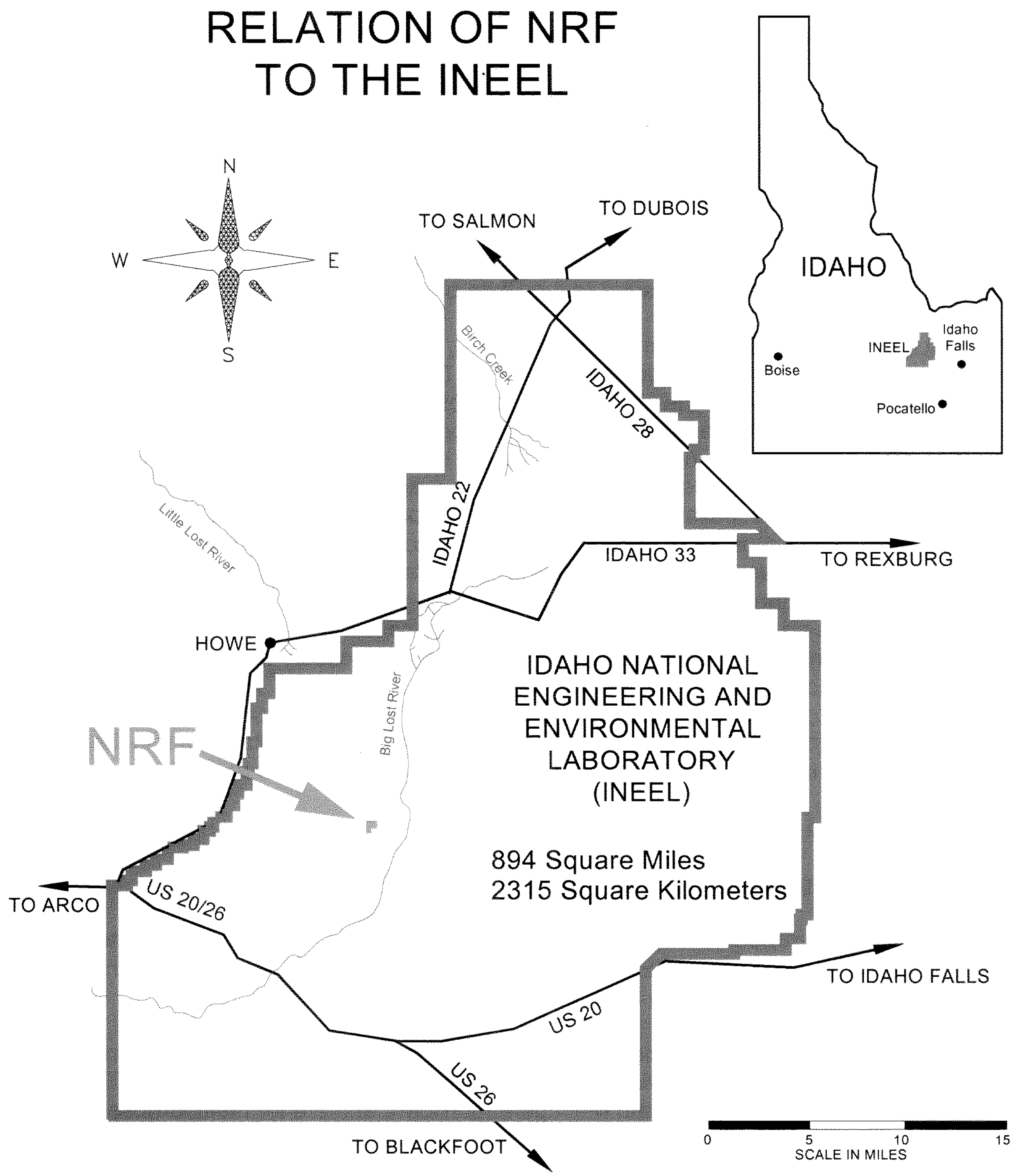

Figure D-1 Location of the Naval Reactors Facility Relative to the INEEL

Public access to the INEEL is strictly controlled by fences and security personnel. State Highways 22, 28, and 33 cross the northeastern portion of the INEEL approximately 15 miles north of NRF, and Highways 20 and 26 cross the southern portion of the INEEL approximately 10 miles south of NRF. A total of 90 miles of paved highways for public use are located on the INEEL.

In 1989, the EPA listed the INEEL on the CERCLA National Priorities List (NPL). A Federal Facility Agreement and Consent Order (FFA/CO) and associated action plan were developed to establish the procedural framework and schedule for developing, prioritizing, implementing, and monitoring response actions at the INEEL in accordance with CERCLA, the Resource Conservation and Recovery Act (RCRA), and the Idaho Hazardous Waste Management Act.

To better manage environmental investigations, the INEEL is divided into 10 Waste Area Groups (WAGs). Identified contaminant controlled areas in each WAG were grouped into Operable Units (OUs) to expedite the investigations and any required remedial actions. NRF is designated as WAG 8. Potentially contaminated sites at NRF were divided into eight OUs. A total of 87 sites were identified. Of the 87 sites identified, 24 sites will require Institutional Controls.

2.2 NRF Background

NRF began operating in 1949 as a prototype site for the Naval Nuclear Propulsion Program. From the mid-1960s to the 1980s, NRF consisted of three operating Naval nuclear reactor prototype plants (S1W, A1W, and S5G), and the Expended Core Facility (ECF). The Submarine Thermal Reactor Prototype (S1W) began operation in 1953 and continued until 1989 when it was permanently shut down. The Large Ship Reactor Prototype (A1W) began operation in 1958 and continued until it was permanently shut down in January 1994. The Submarine Reactor Plant Prototype (S5G) began operation in 1965 and was permanently shut down in May 1995. ECF is housed in a 140,000 square foot building that includes office space, and water pools used for the examination and temporary storage of spent fuel used for the propulsion of Naval nuclear ships. Bechtel Bettis, Inc. operates NRF for DOE, Office of Naval Reactors.

Under provisions of the FFA/CO, NRF completed the Remedial Investigation and Feasibility Study (RI/FS) for the Exterior Industrial Waste Ditch in 1994, remedy selection and implementation for the NRF Inactive Landfill Areas in 1996, and the Comprehensive RI/FS for NRF in 1997. In addition, numerous Track 1 and Track 2 Studies have been performed to evaluate additional NRF CERCLA sites. A Five-year Review of the Inactive Landfill Areas was completed in 2001. Based on the investigations noted above, 24 sites were identified in Record of Decision (ROD) documentation as requiring some type of ICs.

2.3 WAG 8 Controlled Area Locations

For purposes of this document, the sites identified as needing ICs have been divided into three groups based on criteria such as media, type of contamination, or geographic proximity. Group 1 includes the closed landfill sites that have been capped; these sites are NRF-1, NRF-51, and NRF-53 from OUs 8-05 and 8-06. Group 2 includes 13 "No Further Action" sites: NRF-2, NRF-16, NRF-18A, NRF-22, NRF-23, NRF-42, NRF-43, NRF-61, NRF-66, NRF-80, NRF-81, NRF-82, and NRF-83. Group 3 includes 8 radiological sites (OU 8-08): NRF-11, NRF-12A, NRF-12B, NRF-14, NRF-17, NRF-19, NRF-21A, and NRF-21B.

2.3.1 Group 1 Sites (Inactive Landfill Areas)

The covers over the three Group 1 areas were discussed in the CERCLA Five-Year Review (Bechtel, 2001). They were concluded to be in satisfactory condition and remain protective of human health and the environment (although some minor deficiencies existed such as the sparse vegetation coverage at NRF-1). These site are further discussed below. The location of the Group 1 sites is shown in Figure D-2.

2.3.1.1 NRF-1 (Field Area North of S1W)

Use of NRF-1 began circa 1951 and continued until 1960. The locations of the primary disposal areas within NRF-1 were identified from old drawings, photographs, verbal accounts, and written records. Site NRF-1 covers an area of about 192,500 square feet (350 feet wide by 550 feet long). Within this area, there was a previously used trench containing buried waste and a mounded area consisting of surface debris and soil. The buried waste disposal trench was located on the west side of the site. The depth of this trench ranged from approximately 4 feet on the north end to 25 feet on the south end and was 120 feet wide by 375 feet long. Prior to the placement of the final remedial action landfill cover, the trench was originally covered by an interim soil cover (approximately three feet thick). The final cover, constructed in 1996, overlies only the buried wastes in the trenches, and encompasses an area of approximately 56,000 square feet. From historical records, photographs, and drawings, the bulk of the waste was deposited on the southern half of the site where the trench dimensions were greater. In addition, the north end of the trench was covered when Spray Pond #2 was constructed circa 1954 (WEC 1995), thus limiting the amount of wastes that were deposited in the north end of the trench.

2.3.1.2 NRF-51 (West Refuge Pit #4)

NRF-51 started operating circa 1957 and continued until 1963. The shape of this unit is irregular with curved boundaries. The overall size of the site was originally estimated to be approximately 450 feet long, varying in width from 100 to 175 feet. Based on photographs and a magnetometer survey of the location, only one disposal trench was identified. The trench was estimated to be approximately 250 feet in length, 15 to 20 feet wide, and 10 to 15 feet in depth (WEC 1992). The length and width of the trench were further refined by the magnetometer survey and determined to be 175 feet and 40 feet, respectively (WEC 1995). Historical photographs indicated the materials disposed of at this location tended to be related more to construction debris than the wastes found in the other two Inactive Landfill Areas. Also, it was noted that there were no drums in the trench at the time the photographs were taken. NRF believes that a portion of this site was previously used as a construction staging area. The remedial action cover, constructed in 1996, overlies only the buried wastes in the trenches, and encompasses an area of approximately 15,000 square feet.

2.3.1.3 NRF-53 (Landfill Area West of ECF, Outside of Security Fence)

NRF-53 was used as a disposal area from about 1956 to 1970. The various types of waste which may have been disposed of in this area include waste petroleum products, small quantities of waste paints and solvents, construction debris, scrap metal, and cafeteria waste. Magnetometer data indicates that there were at least five pits or trenches at NRF-53. From these data and verbal testimony, the trenches were estimated to have been up to 90 feet wide by 7 to 10 feet deep and up to 350 feet long. The area of site NRF-53 that included both surface debris and the trenches was approximately 400,000 square feet.

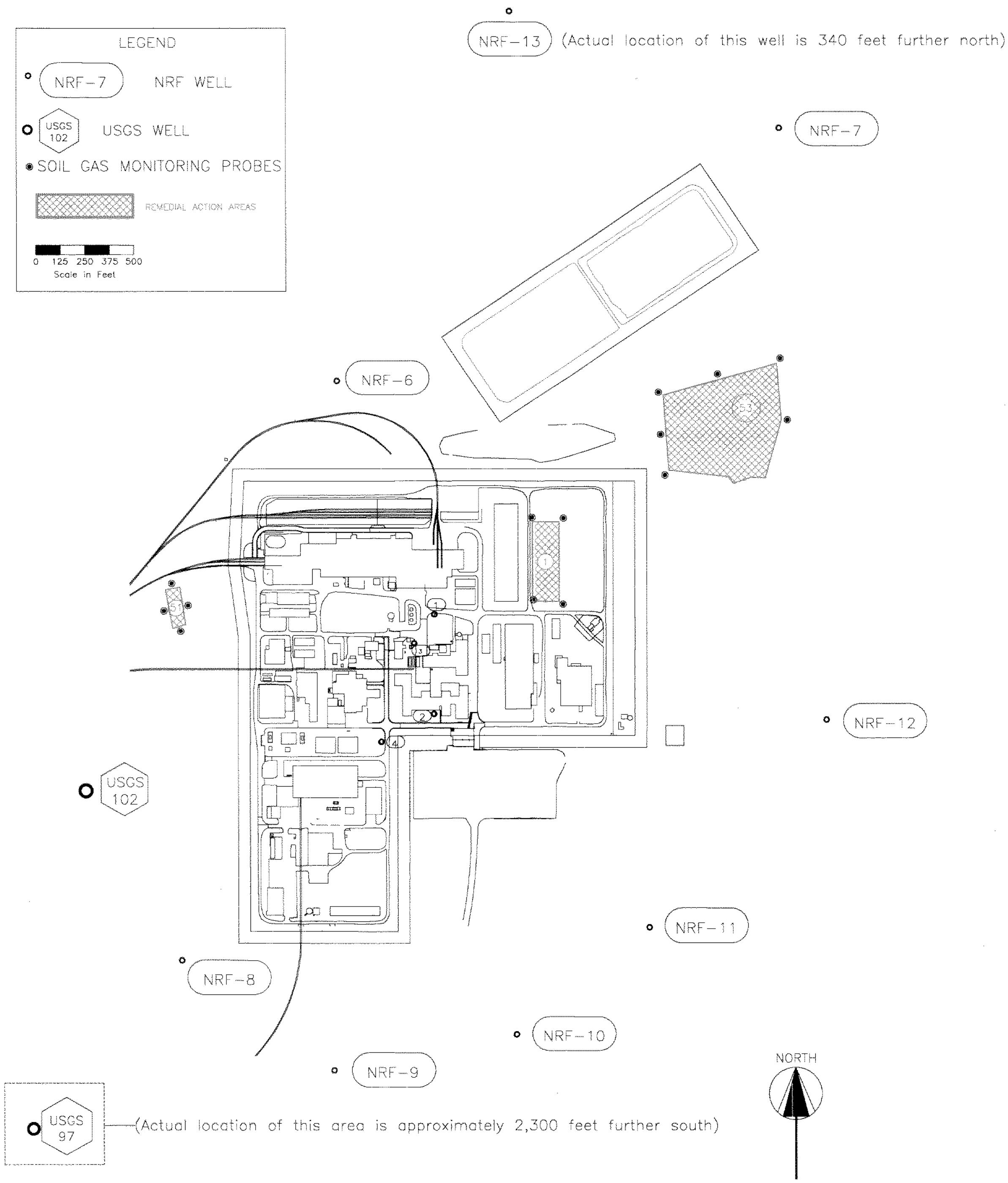

Figure D-2 Location of Landfill Areas (Group 1 Sites)

The remedial action cover, constructed in 1996, overlies only the buried wastes in the trenches, and encompasses an area of approximately 281,000 square feet.

2.3.2 Group 2 Sites (No Further Action)

Group 2 Sites include "no further action" areas. These are sites that contain sources or potential sources that may be present, but an exposure pathway is not available under current site conditions. Because a source may still be present at the 13 No Further Action sites, a review will be performed every five years to verify the effectiveness of the No Further Action decision. Of the 13 sites referenced in this section, 10 sites contain cesium-137 below CERCLA clean up levels established in the ROD. The CERCLA cleanup level for cesium-137 (16.7 pCi/gm) was based on 100 years of institutional controls at which time radioactive decay would reduce the risk to unrestricted levels and a site could be reclassified as "No Action." Two of the sites (NRF-18A and NRF-22) contain non-radiological constituents and may require institutional controls indefinitely (i.e., until they become accessible for further evaluation when the structures over these sites are removed and additional corrective actions are possible)". The last site contains elevated levels of cesium-137 that will not decay to below risk-based levels within 100 years. However, this site is located beneath ECF and its final disposition will be determined when the ECF building is removed. The location of the Group 2 sites is shown in Figure D-3.

2.3.2.1 NRF-2 (Old Ditch Surge Pond)

This site is a pond area that was connected to the Industrial Waste Ditch system. Low levels of radioactivity and slightly elevated levels of metals were detected in the pond. The pond was estimated to have been used from 1959 to 1985. The pond became contaminated with very low levels of radioactivity when water with trace amounts of cobalt-60 and cesium-137 was released to the ditch in the late 1960s. Accumulation of radioactivity in the ditch sediments produced slightly elevated levels, but below remediation (action levels) goals.

2.3.2.2 NRF-16 (Radiography Building Collection Tank Area)

The Radiography Building was originally used for decontaminating/cleaning radioactive equipment. The decontamination solutions were sent to two underground tanks. These tanks were used from 1954 to 1960. Adjacent to the building was a concrete pad that was used for outdoor storage of radioactive material. The concrete pad was removed in 1979. The tanks were removed in 1993 with no indication of leakage. Elevated levels of radionuclides were detected in the surface soil from past spills in the area, but the levels were below remediation (action levels) goals.

2.3.2.3 NRF-18A (S1W Spray Pond #1 and Portions of the Fire Protection System)

The S1W Spray Pond #1 is a large concrete structure that contained cooling water for S1W plant operations. At one time, portions of the fire protection system were connected to the spray pond and a chromium-based corrosion inhibitor was used in the water for these systems. Leakage and overspray from the pond caused elevated chromium concentration in the surrounding soil. The risk assessment showed a low risk for this site while Spray Pond #1 remains in place.

2.3.2.4 NRF-22 (A1W Painting Locker French Drain)

This site is the location of a former french drain that may have received paints, solvents, and/or mercury. A removal action was performed in 1994 after receiving public comment on the proposed action. Sampling performed after the removal action showed elevated levels of lead and mercury remained at the bottom of the hole. The excavated hole was 12 feet deep and was grouted to the surface, eliminating all exposure pathways. The risk assessment of the site after the removal action estimated the risk to be low.

2.3.2.5 NRF-23 (Sewage Lagoons)

This site is the currently operated sewage lagoons, which are two open rectangular ponds that measure 425 feet by 725 feet each. Elevated levels of metals and radionuclides and trace amounts of organics have been detected in the sediment of the lagoons. The risk assessment assumed an institutional control period of 100 years. The risk assessment was very conservative and a risk management decision was made that the actual risks are acceptable.

2.3.2.6 NRF-42 (Old Sewage Effluent Ponds)

This site is the location of a former temporary sewage pond used in the 1950s. There is no evidence that a hazardous source exists at the site, but elevated amounts of metal, semi-volatile organic, and low-level radionuclide contaminants may be present based on sampling performed in the current sewage lagoons. The site is currently covered with a 10 foot layer of soil. Based on current conditions (i.e., 10 foot soil cover), the risk was estimated to be low.

2.3.2.7 NRF-43 (Seepage Basin Pumpout Area)

This site is an area where the contents of NRF-21A (Old Sewage Basin) were pumped out in 1958. Slightly elevated amounts of radioactivity have been detected in the area. The risk assessment showed an acceptable risk for the 100-year future residential scenario.

2.3.2.8 NRF-61 (Old Radioactive Materials Storage and Laydown Area)

This site is a former location of a radioactive material storage and laydown area that was used from 1954 to 1960. Soil sampling showed detectable amounts of cesium-137. The risk was estimated to be low based on an institutional control period for the future residential scenario, and is well below remediation goals.

2.3.2.9 NRF-66 (Hot Storage Pit)

This site is an area where a tanker truck collected radioactive liquid waste for transportation to other INEEL facilities for processing. Spills reportedly occurred in this area and contaminated soil was removed from the area in 1980. Slightly elevated levels of cesium-137 were detected at the site during the remedial investigation, but the levels were well below remediation goals.

2.3.2.10 NRF-80 (A1W/S1W Radioactive Line Near BB19)

This area consists of an underground pipe that was known to have leaked near S1W Spray Pond #1. The pipe carried radioactive water for eventual discharge to the S1W Leaching Beds. The radioactive line was removed; however, elevated low levels of cobalt-60 remain at the site, below risk-based activity levels.

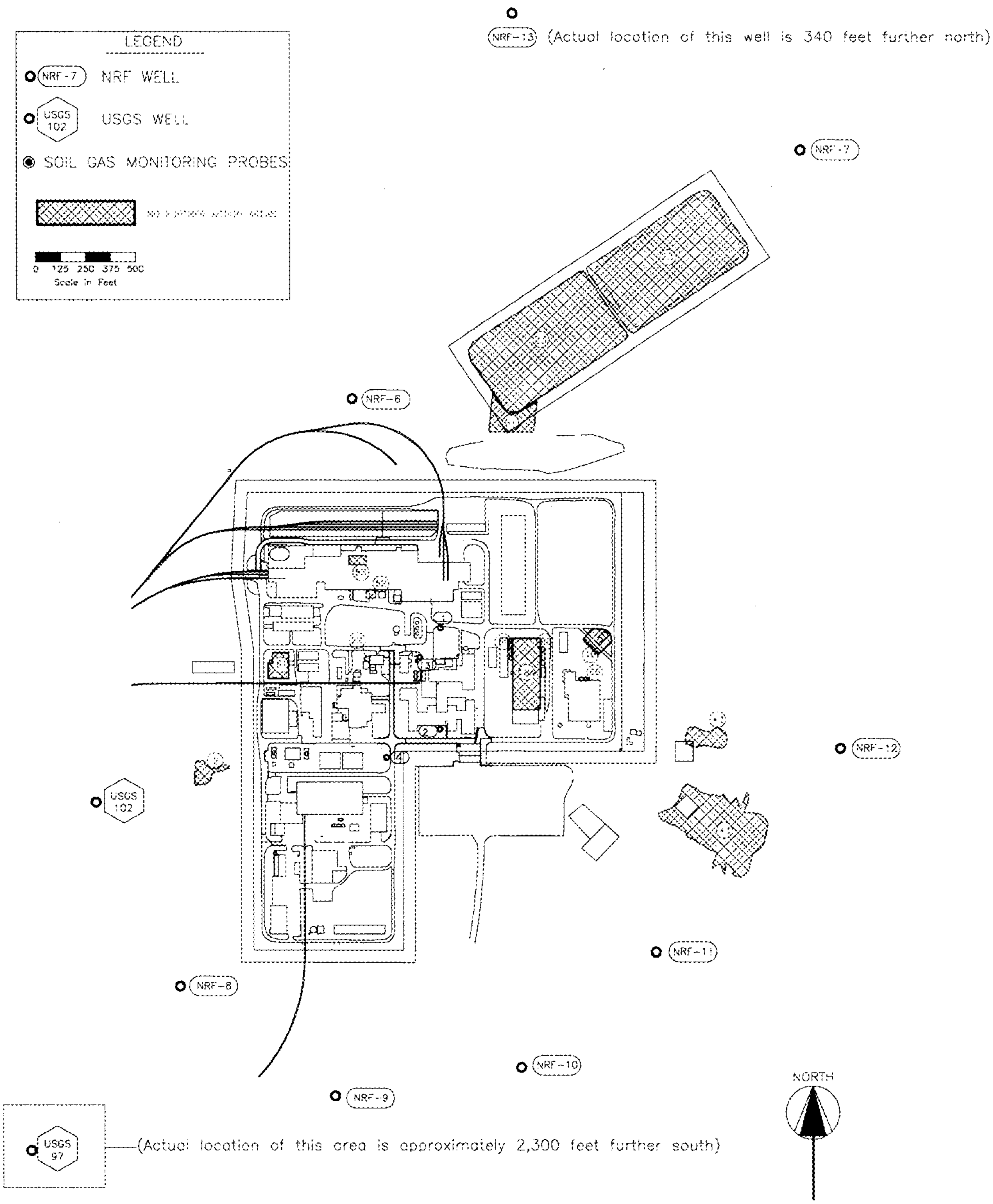

Figure D-3 Location of No Further Action Areas (Group 2 Sites)

2.3.2.11 NRF-81 (A1W Processing Building Area Soil)

This site is an area around a radioactive process building where a few spills occurred in the past. Typically these spills were cleaned up to the maximum extent possible at the time. Cesium-137 and cobalt-60 were the only radionuclides detected at elevated levels during past sampling. The levels were below remediation goals.

2.3.2.12 NRF-82 (Evaporator Bottoms Tank Release)

This site consists of the soil surrounding a concrete tank vault. A spill occurred at the area in 1972. The spill was cleaned up to the standards in place at the time of the spill and additional construction has since occurred in the area. Slightly elevated amounts of radioactivity were reported after the cleanup was performed in 1972, and additional soil cleanup occurred in 1977. The remaining radioactivity is below remediation goals.

2.3.2.13 NRF-83 (ECF Hot Cells Release Area)

This site is the location of a radioactive liquid release that occurred in 1972. Radioactive liquid was released from a pipe to a concrete trench, and the soil below and adjacent to the trench became contaminated. Cleanup actions taken in 1972 did not include the soil below the trench. The contaminated soil was discovered in 1997 when a concrete pad adjacent to the concrete trench was removed during ECF upgrade work. Elevated levels of cobalt-60 and cesium-137 are present in the soil. All accessible contaminated soil was removed and replaced with clean soil. An estimated 28 cubic meters of contaminated soil remains under the trench to preserve the integrity of the trench. A new concrete pad was poured at the location of the old concrete pad excavation. The contaminated soil below the trench is not presently accessible and no exposure route is available.

2.3.3 Group 3 Sites (OU 8-08 Radiological Sites)

OU 8-08 Radiological Sites are those areas that require remediation per the NRF Comprehensive RI/FS and as documented in the NRF Record of Decision. Remediation work includes the removal of contaminated soil and buried piping, and the capping of several sites with engineered covers. The location of the Group 3 sites is shown in Figure D-4.

2.3.3.1 NRF-11 (S1W Tile Drainfield and L-shaped Sump)

This area consists of a below surface concrete L-shaped sump and various underground perforated drainfield pipes downstream of the sump. The drainfield was estimated to have been used between 1953 and 1955. The L-shaped sump portion was used until 1960 as part of the sewage system. Known discharges of radioactive water occurred at this site and potential contamination above the remediation goal may be present. The L-shaped sump and drainfield piping and associated contaminated soil will be removed during remedial actions, leaving only soil with low levels of contamination below remediation goals.

2.3.3.2 NRF-12 (S1W Leaching Pit)

This site has been redefined as two separate areas for evaluation purposes. NRF-12A consists of: (1) an underground pipe leading from the S1W retention basins (NRF-17) to a subsurface concrete manhole; this pipe is known to have leaked on occasion; (2) the manhole itself; and (3) from the manhole, a perforated pipe used for draining or leaching purposes, running 400 feet to a leaching pit (NRF-12B) at the end of the pipe. NRF-12B was a pond area where radioactive water below existing release criteria was allowed to leach into the subsurface or evaporate. The underground perforated piping (NRF-12A) and leaching pit (NRF-12B) were used from 1955 through 1961. The pond area has since been filled in and covered with asphalt. The various piping, manhole, and associated contaminated soil at NRF 12A will be removed during remedial actions, leaving only soil with low levels of contamination below remediation goals. NRF-12B will be capped with an engineered cover along with the adjacent site, NRF-14.

2.3.3.3 NRF-14 (S1W Leaching Beds)

This area consists of two leaching beds: one constructed in 1960 and the other in 1963. These beds were open ponds that collected radioactive water below existing release criteria and allowed the water to leach into the subsurface or evaporate. Large cobblestones were placed in the leaching beds in the mid 1970s. The beds were used until 1979. The piping leading to the beds has been removed. Little or no contamination was found near the piping. These beds will be capped along with NRF-12B.

2.3.3.4 NRF-17 (S1W Retention Basins)

The S1W Retention Basins are concrete basins partially below grade that collected radioactive water from various facilities. This was a storage area prior to releasing the water to NRF-11, NRF-12, or NRF-14. The basins are known to have leaked an estimated 33,000 gallons on one occasion. The concrete basins have been removed, and the soil beneath the basins has been remediated to the cleanup criteria established in the Record of Decision for the NRF Comprehensive RI/FS, leaving only soil with low levels of contamination below remediation goals.

2.3.3.5 NRF-19 (A1W Leaching Bed)

This area consists of an underground leaching bed built in 1957. A perforated pipe runs through the engineered leaching bed, which consists of various layers of gravels and sand. The A1W Leaching Beds were used continuously through 1964, and then sporadically until 1972, after which they were abandoned. Piping leading to the leaching beds, along with associated contaminated soil above cleanup levels, has been removed. The area will be capped with an engineered cover.

2.3.3.6 NRF-21 (Old Sewage Basin)

This site has been redefined as two separate areas for evaluation purposes. NRF-21A consists of a former sewage basin area. The basin was an open pond used for non-radiological discharges. Cross-contamination from the radiological discharge system occurred in 1956. NRF-21A was used from 1956 to 1960. NRF-21B is a 27 foot by 29 foot "sludge drying bed" and consists of a concrete bottom overlain by layers of sand and gravel. The bottom of the bed is below surface level. NRF-21B received sewage sludge from the sewage system and was cross-contaminated by the radioactive discharge system when NRF-21A became contaminated. NRF-21B was used from 1951 to 1960. At NRF-21A, the piping and associated contaminated soil will be removed and the basin will be capped with an engineered cover. At NRF-21B, the sludge drying bed, piping, and associated soil will be removed, leaving only soil with low levels of contamination below remediation goals.

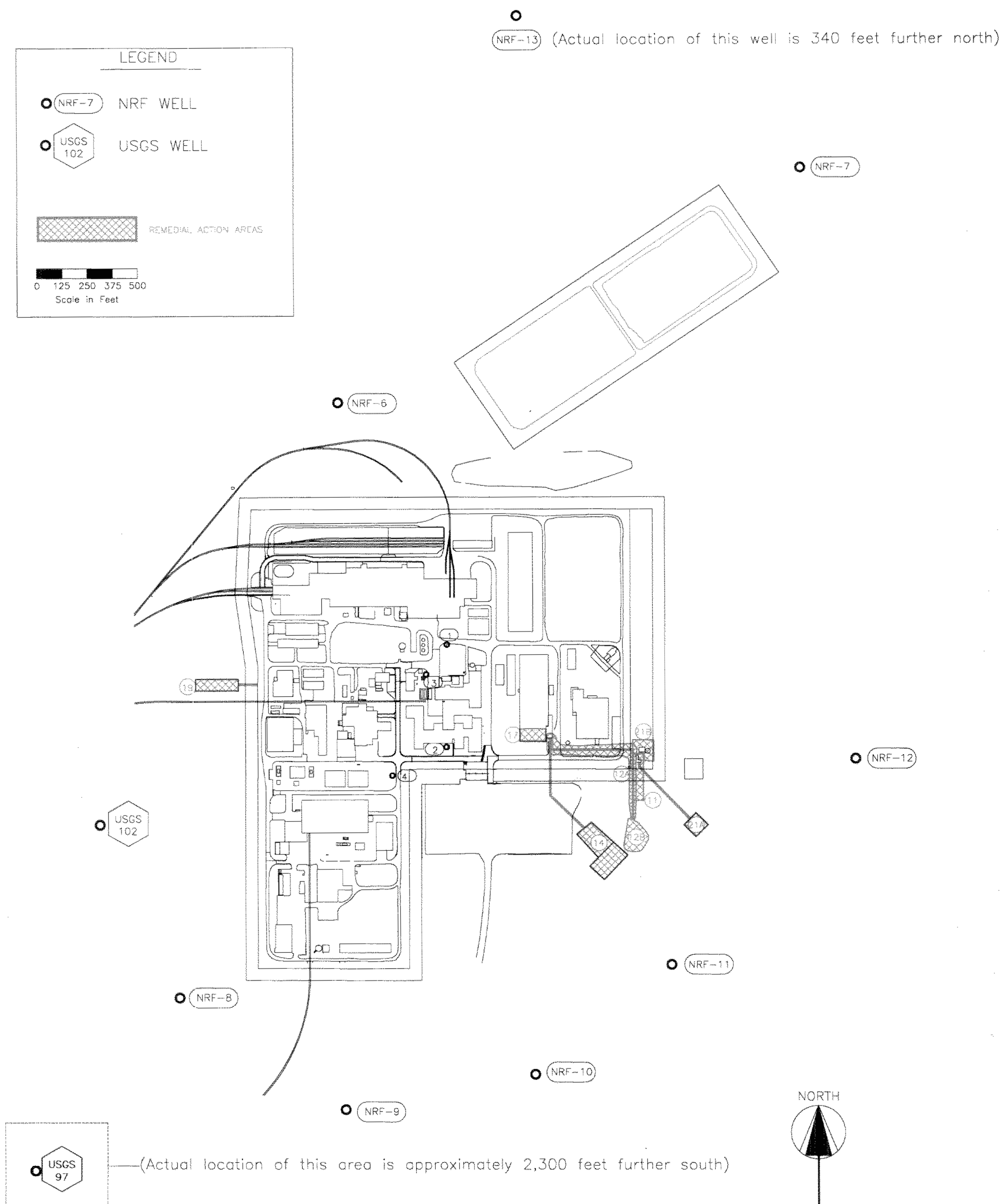

Figure D-4 Location of Radiological Areas (Group 3 Sites)

Table D-1 Summary of 100 Year Institutional Controls at NRF

Location		Objective	Tools to Achieve Objective
Group 1 (Landfill Areas)			
NRF-1	Field Area North of S1W	Prevent unauthorized access and excavation	• Fencing • Excavation Controls • Signs • Inspections
NRF-51	West Refuge Pit #4	Prevent unauthorized access and excavation	• Fencing • Excavation Controls • Signs • Inspections
NRF-53	East Refuge Pit and Trenching Area	Prevent unauthorized access and excavation	• Fencing • Excavation Controls • Signs • Inspections
Group 2 (No Further Action Sites (NFAS))			
NRF-2	Old Ditch Surge Pond	Prevent unauthorized excavation	• Excavation Controls • Signs • Inspections
NRF-16	Radiography Building Collection Tank Area)	Prevent unauthorized excavation	• Existing fence also within NRF Fenced Area • Excavation Controls • Inspections
NRF-18A	S1W Spray Pond #1 and Portions of the Fire Protection System	Prevent unauthorized excavation	• Within NRF Fenced Area • Signs • Excavation Controls* • Inspections
NRF-22	A1W Painting Locker French Drain	Prevent unauthorized excavation	• Within NRF Fenced Area • Signs • Excavation Controls* • Inspections
NRF-23	Sewage Lagoons	Prevent unauthorized excavation	• Existing Fencing • Signs • Excavation Controls • Inspections
NRF-42	Old Sewage Effluent Ponds	Prevent unauthorized excavation	• Excavation Controls • Signs • Inspections

*Currently beneath a structure.

Table D-1 Summary of 100 Year Institutional Controls at NRF (Continued)

	Location	Objective	Tools to Achieve Objective
Group 2 Continued (NFAS)			
NRF-43	Seepage Basin Pumpout Area	Prevent unauthorized excavation	• Excavation Controls • Signs • Inspections
NRF-61	Old Radioactive Materials Storage and Laydown Area	Prevent unauthorized excavation	• Excavation Controls • Signs • Inspections
NRF-66	Hot Storage Pit	Prevent unauthorized excavation	• Within NRF Fenced Area, additional fencing not required • Signs • Excavation Controls • Inspections
NRF-80	A1W/S1W Radioactive Line Near Butler Building 19	Prevent unauthorized excavation	• Within NRF Fenced Area • Excavation Controls • Signs • Inspections
NRF-81	A1W Processing Building Area Soil	Prevent unauthorized excavation	• Within NRF Fenced Area • Excavation Controls • Signs • Inspections
NRF-82	Evaporator Bottoms Tank Release	Prevent unauthorized excavation	• Within NRF Fenced Area • Excavation Controls • Signs • Inspections
NRF-83	ECF Hot Cells Release Area	Prevent unauthorized excavation	• Within NRF Fenced Area • Excavation Controls* • Signs • Inspections

*Currently beneath a structure.

Table D-1 Summary of 100 Year Institutional Controls at NRF (Continued)

	Location	Objective	Tools to Achieve Objective
Group 3 (8-08 Radiological Sites)			
NRF-11	S1W Tile Drainfield and L Shaped Sump	Prevent unauthorized excavation	• Portion within NRF Fenced Area • Excavation Controls • Signs • Inspections
NRF-12A	Underground Piping to Leaching Pit	Prevent unauthorized excavation	• Portion within NRF Fenced Area • Excavation Controls • Signs • Inspections
NRF-12B	S1W Leaching Pit	Prevent unauthorized access and excavation	• Fencing • Excavation Controls • Engineered Earthen Cover • Signs • Inspections
NRF-14	S1W Leaching Beds	Prevent unauthorized access and excavation	• Fencing • Excavation Controls • Engineered Earthen Cover • Signs • Inspections
NRF-17	S1W Retention Basin	Prevent unauthorized excavation	• Within NRF Fenced Area • Excavation Controls • Signs • Inspections
NRF-19	A1W Leaching Bed	Prevent unauthorized access and excavation	• Fencing • Excavation Controls • Engineered Earthen Cover • Signs • Inspections
NRF-21A	Old Sewage Basin	Prevent unauthorized access and excavation	• Fencing • Excavation Controls • Engineered Earthen Cover • Signs • Inspections
NRF-21B	Sludge Drying Bed	Prevent unauthorized excavation	• Within NRF Fenced Area • Excavation Controls • Signs • Inspections

3.0 Institutional Controls

A description of the ICs to be used at WAG 8 is presented briefly in this section. Table D-1 above summarizes the ICs used at NRF. Not all ICs identified on Table D-1 are required components for each site, but are identified in Table D-1 to emphasize the tools currently in place to prevent unauthorized excavation. For example, some of the "No Further Action" sites are currently fenced and, although fencing is not a necessary component to prevent unauthorized excavation, it is a component currently in place that will be maintained.

3.1 Visible Access Restrictions

Visible access restrictions are those ICs that deal with restricting personnel access to a specific controlled area. At WAG 8, these restrictions will be perimeter fencing or permanent markers and warning signs. Warning signs will clearly identify the concerns at the controlled area and will be visible from all avenues of approach. Section 4 of this ICP details sign specifications and procedures for instituting and inspecting the visible access restrictions.

3.2 Control of Activities

Control of activities includes those ICs that deal with the administrative controls relating to a controlled area. These ICs will cover all entities and persons including, but not limited to, employees, contractors, lessees, and visitors that access a controlled site. Although it is unlikely that routine trespassing would occur during DOE operations, trespassers will be included. The ICs will cover all activities and reasonably anticipated future activities including, but not limited to, any future soil disturbance, routine and non-routine utility work, well placement and drilling, recreational activities, groundwater extraction, paving, training activities, construction, and renovation work on structures or other activities that might occur at a controlled area. These controls include, but are not limited to, the following:

- Bettis Site Development Plan
- Public Notice
- DOE Directives
- Technical Work Documents (TWDs)
- Personnel Training
- Excavation Control Plan

Disturbances, excavation, and management of WAG 8 environmentally controlled areas will be specifically controlled through procedures described in Section 4 of this document.

3.3 Unauthorized Access

Unauthorized Access refers to those ICs that prevent the unauthorized entry of personnel and vehicles into a controlled area. At other INEEL facilities as well as at NRF, identification badges are required to enter unescorted. Otherwise, any unbadged member of the public that visits NRF or other INEEL facilities first must pass through a check point, be given a temporary badge, and be escorted by authorized personnel to the various sites. Section 4 of this document details the procedures for restricting access to the controlled areas.

At NRF, all CERCLA sites are either within the main NRF fenced area or within a short distance of the outer perimeter fence (i.e., within areas monitored by NRF Security). In addition, INEEL security personnel are responsible for controlling access onto the INEEL and for patrolling all areas at the INEEL outside secured compounds, including NRF. INEEL security is effective in stopping accidental incursion onto the INEEL and prohibiting deliberate incursion. Thus, CERCLA areas outside the NRF perimeter fence are protected.

Although INEEL personnel are responsible for security outside the NRF perimeter fence, areas that are near NRF are watched and patrolled by NRF security personnel as well. Any unusual or unexpected activity outside the perimeter fence is immediately reported to and investigated by INEEL and/or NRF security personnel. Any activities being performed by NRF personnel outside the perimeter fence must be reported to NRF security.

As part of local security measures, all NRF personnel receive badges that must be worn in a conspicuous location at all times. This significantly reduces the chance that unauthorized personnel could intrude onto the NRF site in general, and specifically the CERCLA sites, without being detected. Similar badging procedures are practiced at other INEEL sites.

3.4 Notice to Affected Stakeholders

Some controlled areas require special notification be made to affected stakeholders prior to any change in land use designation, land-use restriction, or land user. Specifics on EPA's notifications of land use change are discussed further in Section 4. The specific stakeholders include, but may not be limited to, the following:

- Bureau of Land Management
- ShoBan Tribal Council
- U.S. Fish and Wildlife Service
- Local county governments
- Local city governments
- State of Idaho
- Environmental Protection Agency

When notification is required, NRF will coordinate its efforts with the INEEL Community Relations Plan Group.

4.0 Implementation Methodologies and Procedures

4.1 Visible Access Restrictions

Warning signs required for ICs will be conspicuously placed intermittently along the boundary of a controlled area. In placing signs, the location will be adjusted in consideration of doors or other obstructions that may alter or interfere with the visibility of the signs. At least one sign will be placed on each side of an area's boundary, and the signs will be visible from any normal path of approach. Signs will be placed at a distance of no more than 200 feet apart, but may be closer if the line of sight along the boundary is hampered.

To be consistent with other INEEL sites, NRF CERCLA warning signs will possess an orange background with black lettering, the font of which will be proportional to the size of the sign. Signs and labels will be built to endure expected environmental conditions without significant deterioration of color, legibility, strength, or other physical characteristics. Signs will be at least 8.5 x 11 inches.

Warning signs will indicate site name, general hazard (i.e., 'Radionuclides', 'Metals', etc.), access restrictions (i.e., 'No Unauthorized Excavation'), and point of contact (e.g.., 'Environmental Affairs').

Boundary markers or identifiers will consist of fences, chains, permanent surveyed markers, or other material sufficient to delineate the boundary of the area. Boundary identifiers and physical barriers will be clearly visible from all normal access directions and various elevations to prevent inadvertent access to areas. Fences and signs will be used as boundaries if signs alone are inadequate for preventing inadvertent access to the area.

Warning signs will be securely affixed and located such that signs and labels can be expected to remain in place when subjected to expected adverse conditions and environments. The signs will be placed after completion of Phase II Remedial Actions.

4.2 Control of Activities

Those sites where no contamination is found during the remedial action, or where contamination is not present above levels for unrestricted use after the remedial action has been completed, will not require institutional controls. When required, the following controls may be utilized.

4.2.1 Bettis Atomic Power Laboratory Site Development Plan

The Bettis Atomic Power Laboratory Site Development Plan (SDP) will be updated after completion of the Phase II Remedial Action. The NRF SDP will include a legal description of the real property and a map showing the location of the property for which the institutional controls will be in effect. The SDP will also include specific activities that are prohibited, including prohibitions against certain land use such as excavation in capped areas.

4.2.2 The Operation and Maintenance Plan

The Operation and Maintenance (O&M) Plan contains instructions for surveying the coordinates associated with the site boundaries requiring ICs. Maintenance and inspection requirements for the covers, soil gas probes, soil moisture probe access tubes, and groundwater monitoring wells are also contained in the applicable O&M Plans.

4.2.3 Public Notices

Stakeholders are individuals, groups, and organizations that will be or believe they may be affected by cleanup activities at NRF, in the event of future transferring or leasing of property, and who therefore want to be involved. Primary stakeholder groups include (but are not limited to) the Federal Government, State Government, Counties, Tribes, Cities, printed news media, broadcast media, advertisers, and other organizations. Secondary stakeholders include the general population of Idaho, western Wyoming, and southwest Montana. Table D-2 lists in detail the various stakeholders considered at NRF.

Depending on circumstances, NRF will provide public notification of any changing future conditions in several ways. This may be in the form of providing the INEEL Information Repository with copies of routine NRF documents (e.g., NRF Institutional Monitoring Report). In other instances, information may be released through the INEEL Community Relations Plan Group via local newspaper advertisement (e.g., the NRF Five-Year Reviews). This might also occur if a hazardous release occurred due to intrusion or other failed institutional controls at a

CERCLA site. For land use changes and property leasing or transfer, the NRF WAG-8 manager, in conjunction with the INEEL Community Relations Plan Group, is responsible for contacting stakeholders and providing the news media with appropriate information. At least six months prior to any NRF property lease or property conveyance involving controlled CERCLA areas, stakeholders will be informed. In addition, stakeholders will be routinely informed every five years of land use status through the CERCLA five-year review process.

4.2.4 Department of Energy (DOE) Directives

DOE Directives include policies, orders, manuals, and guides that are intended to direct, guide, inform, and instruct employees in the performance of their jobs, and enable them to work effectively within the Department and with agencies, contractors, and the public. Because Naval Reactors is a hybrid between DOE and the Department of Defense (DOD), some DOE Directives may not apply to NRF. Where appropriate, NRF will comply with applicable DOE Directives. At this time, several directives cover general environmental concerns that are relevant to NRF.

4.2.5 Radiological Controls

At NRF, areas with the potential of being radiologically contaminated are strictly controlled for access to minimize the potential spread of radioactivity. CERCLA sites with radioactivity present fall under this umbrella of protection and are thus strictly controlled. Written authorization is required to enter and perform work within such areas.

Technical Work Documents (TWDs) receive extensive review by both radiological control and CERCLA personnel when affecting a CERCLA site. TWDs identify radiological conditions, establish worker protection and monitoring requirements, and contain specific approvals for radiological work activities.

4.2.6 Personnel Training

Personnel training is an IC that is used to help prevent or minimize exposure to hazards at NRF CERCLA sites. Training programs are designed to inform the general working population at NRF of the hazards associated with CERCLA sites. Each employee at NRF receives general Environmental Safety and Health (ESH) training, in the form of annual training and weekly bulletins covering a broad range of ESH issues, including issues related to CERCLA. All NRF employees and subcontractors are routinely trained to be sensitive to identification of CERCLA sites, and instructed not to enter any CERCLA site without first contacting Environmental controls personnel. These general training issues will continue after completion of CERCLA remedial actions.

For work performed at NRF, it is the responsibility of the project supervisor to ensure that personnel have the proper and required training prior to commencing work. The project supervisor also has the authority to deny access to radiological or special hazard areas for personnel who do not meet area access training requirements.

Training is the primary tool at NRF to ensure that all personnel know their responsibilities. NRF has several training programs that contribute to the concept of Institutional Controls. For example, the Environmental Training Program helps ensure that personnel involved in activities with environmental concerns will follow procedures and communicate with others as needed.

Table D-2 Detailed Listing of Stakeholders Potentially Effected by NRF CERCLA Actions

Federal Government	State Government	Counties	Tribes	Cities	News Media	Broadcast Media	Advertisers	Others
Department of the Navy	Idaho Governor's Office	Bannock	Shoshone-Bannock	Aberdeen	Arco Advertiser	KTVB Boise	Daily News	Local Chambers of Commerce
Naval Reactors	Idaho Attorney General	Bingham	Nes Perce	Arco	Statesman	KIVI Nampa/Boise	DOE Progress	Local Civic Organizations
DOE-PNR	Bureau of Disaster Services	Blaine		Atomic City	Times-News	KBCI Boise	Inside Energy	Coalition 21
Idaho Congressional	Idaho Legislature	Butte		Blackfoot	Idaho State Journal	KLEW Lewiston	EM Progress	Environmental Defense Institute
EPA	Emergency Response Commission	Clark		Buhl	Post Register	KMVT Twin Falls	Weapons Complex Monitor	Greater Yellowstone Coalition
Craters of the Moon National Monument	Department of Water Resources	Custer		Burley	Sho-Ban News	KIDK Idaho Falls/Pocatello		Idaho Conservation League
Department of the Interior	Department of Transportation	Fremont		Repert		KRIC Rexburg		Idaho Migrant Council
National Oceanic and Atmospheric Administration	Department of Commerce	Jefferson		Twin Falls		KTFI Idaho Falls/Pocatello		INEEL Citizen Advisory Board
Argonne National Laboratory-West	Idaho Department of Environmental Quality	Madison		Howe		KSEI Pocatello		INEEL Employees
Nuclear Regulatory Commission		Minidoka		Idaho Falls		KART Jerome		League of Women Voters
				Ketchum-Sun Valley		KBOI Boise		Natural Resources Defense Council
				Carrie		KPVI Idaho Falls/Pocatello		Snake River Alliance
				Mud Lake		KUOI Moscow		Keep Yellowstone Nuclear Free
				Pocatello		KIFI Idaho Falls/Pocatello		Greenpeace
				Terreton		KBSU Boise		Sierra Club

4.2.6.1 Radiological Training

Radiological safety training is provided to all NRF employees to one degree or another. As a minimum, all employees and visitors to the NRF site are trained to recognize warning signs associated with the CERCLA areas, and that they are to obey these signs. If work is to be done such that the employee has the potential of being exposed to ionizing radiation, additional training is provided. The level of training is commensurate with the potential exposure and the difficulty of the task being performed.

4.2.6.2 Occupational Safety and Health Training

The Occupational Safety and Health Administration (OSHA), as described in 29 CFR 1910.120, requires that any employee performing work involving hazardous waste or hazardous substances complete appropriate levels of Hazardous Waste Operations and Emergency Response (HAZWOPER) training courses. Requirements of the OSHA HAZWOPER training program will be implemented as appropriate.

4.2.7 Excavation Controls

An important aspect of NRF ICs for the control of activities at WAG 8 will be proper management of soil disturbances in environmentally controlled CERCLA areas. NRF controls unauthorized or accidental excavation in these areas using a combination of training and engineering controls, to ensure that no excavation occurs without first obtaining the concurrence of Site environmental personnel. These controls are included in several NRF guidance and policy manuals. Together, these actions constitute site-wide ICs for controlling excavation activities. The specific processes required to disturb, excavate, and manage soils are discussed below.

4.2.7.1 Cognizant Engineer/ESH Engineer

The Cognizant Engineer or Scientist (CE/S) is the person primarily responsible for ensuring that rules for various work functions are followed and that work is performed according to a written procedure. All work at NRF is documented in one of three ways. These are Preventive Maintenance (PM) cards, Technical Specifications (for subcontracted work), or Technical Work Documents (for NRF labor tasks). These documents and associated work are reviewed and approved by NRF personnel assigned to areas of environmental, safety, and health.

4.2.7.2 Excavation Permits

Integral to the process of preventing unauthorized excavation of CERCLA sites is the "Excavation Permit." This permit is initiated by the CE/S, and is required for all excavation activities at NRF. The Excavation Permit identifies each NRF organization that must be notified prior to the commencement of excavation, including Radiological Controls, Environmental Remediation (for CERCLA), Environmental Affairs, and Safety. Cognizant personnel are trained in the initialization procedures and use of the Excavation Permit.

4.2.7.3 Personnel Training

Training is the primary tool used at NRF to ensure that the CE/S and other personnel know their responsibilities, follow procedures, and communicate with others as needed. NRF has several training programs that contribute to the concept of Institutional Controls. For example, each employee at NRF receives general ESH training, in the form of annual training and weekly bulletins covering a broad range of ESH issues. In addition, all NRF employees and subcontractors are routinely trained to be sensitive to identification of CERCLA sites, and instructed not to enter any CERCLA site without first contacting the proper environmental controls personnel.

4.3 Response to Failed Controls/Corrective Action

Failed ICs are most likely to be found during the annual inspections; however, failed ICs may be discovered at any time. Notification of the EPA and the State of Idaho will be made by DOE/NR upon discovery of any activity that is inconsistent with the specific IC objectives for a site or of any change in the land use or land use designation of a controlled area. Reportable items or circumstances may include:

- The integrity of an engineered cover is compromised;
- An unauthorized individual accesses a controlled area;
- A controlled area is used in an inappropriate manner; or
- A release of a hazardous or radiologically controlled material occurs at a controlled area.

In the event that ICs are breached, NRF will work together with the EPA and the State of Idaho to determine a plan of action to rectify the situation. In the event that the breach of the IC constitutes an emergency, NRF will immediately notify the EPA and the State of Idaho; however, this will not delay emergency cleanup actions as necessary.

5.0 Leasing or Transfer of Property

NRF does not anticipate that the land within WAG 8 will be subject to leasing or property transfer through the year 2095. This presumption served as the basis for cleanup levels stipulated in the ROD. The Hall Amendment of the National Defense Authorization Act of 1994 requires concurrence from EPA on the lease of any National Priorities List sites during the period of DOE control, and CERCLA requires that the State be notified of a lease involving contamination. When DOE/NR no longer manages NRF activities and separate controls are needed to supported a land transfer, CERCLA requires that DOE/NR indicate the presence of contamination and any restrictions in property transfer documentation.

If possible, DOE/NR will notify the EPA and the State of Idaho at least six months prior to any WAG 8 transfer, sale, or lease of any property still subject to ICs required by the WAG 8 ROD, so that the EPA and the State of Idaho can be involved in discussions to ensure that appropriate provisions are included in the conveyance documents to maintain effective ICs. If it is not possible for DOE/NR to notify the EPA and the State of Idaho at least six months prior to any transfer, sale, or lease, DOE/NR will notify the EPA and the State of Idaho as soon as possible, but no later than 60 days prior to the transfer, sale, or lease of any property subject to ICs.

6.0 Changing/Terminating Institutional Controls

ICs are required as long as land use or access restrictions are necessary to maintain protection of human health and the environment. The adequacy of and need for the continued use of institutional controls for each controlled area will be evaluated during the annual inspections and the five-year review process. ICs will not be changed or terminated unless the EPA and the State of Idaho have concurred.

7.0 Inspections

NRF will perform annual inspections of the WAG 8 controlled areas (i.e., capped areas and "No Further Action" sites, which have ICs) prior to October 31 of each year (target timeframe of June/July) to ensure the ICs remain protective of human health and the environment. Results of the inspection for the "No Further Action Sites" will be recorded on an inspection form (see Attachment 1), and photographs will be taken of the areas. IC inspections of the capped areas will be combined with the inspections discussed in the O&M Plan (see Section 2.0). Elements of the site inspection are as follows:

1. Observe any evidence of human or animal intrusion within an area designated for restricted access.

2. Verify that warning signs clearly identify IC concerns, are clearly visible from all avenues of approach to the IC area, and are intact and readable.

3. Verify that IC fenced areas are completely enclosed with all gates(s) locked (if applicable). Verify that fences are intact (if applicable).

4. Confirm that required boundary monuments are intact and readable.

5. Search for indications of unauthorized excavation in the IC controlled area.

6. Ensure that that the monitoring wells/probes are locked.

7. Provide a description of any deficiencies, beyond those noted above (e.g., additional details, or other issues not listed above).

8. Describe any additional IC requirements that may be necessary due to unique circumstances observed during the visual inspection.

Other inspections are performed on the groundwater wells, soil-gas probes, soil moisture probed access tubes, and capped areas. Inspection details are contained in the O&M Plan for the OU 8-05/6 Landfill covers, and in the O&M Plan for the OU 8-08 site covers (Appendix C).

8.0 Reporting

The results from the IC inspections described in Section 7 will be used to develop IC monitoring reports, which will be submitted annually (prior to December 31) in accordance with the EPA Region 10 IC Policy.

9.0 Record Keeping

A set of the records specific to WAG 8 will be kept in the project files and the WAG 8 Information Repository. Documents will include, but not be limited to, the IC Plan, annual IC Monitoring Reports, and Five-year Review Reports.

10.0 Project Management and Enforcement

The WAG 8 remediation project manager or their designate is responsible for ensuring the IC activities are performed in accordance with this plan.

Attachment 1

Institutional Controls Field Inspection Checklist

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ANNUAL INSPECTION REPORT FORM FOR WAG 8
INSTITUTIONAL CONTROLS CHECKLIST

Date____________________

		No Further Action Sites						
	IC Inspection Activity							Comments/Modifications
1.	Look for evidence of human or animal intrusion.							
2.	Inspect signs.							
3.	Inspect fences.							
4.	Inspect boundary markers.							
5.	Look for signs of unauthorized excavation.							
	Miscellaneous							
1.	Additional deficiencies (use space below)							
2.	Additional Institutional Controls (use space below)							

Additional
Deficiencies____

(Attach Additional Sheets as Necessary)

Additional Institutional
Controls____

(Attach Additional Sheets as Necessary)

Printed Name of Inspector________________________ Photographs Taken? Yes No

Signature________________________ If Taken, Number ______________

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Appendix E

Waste Management Plan

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1.0 Purpose

The Waste Management Plan (WMP) describes the management of wastes generated during the Phase II Remedial Action for Operable Unit (OU) 8-08. The WMP identifies the types and volumes of wastes being generated, provides hazardous waste determinations for each of the waste streams, describes waste minimization actions, and describes the waste transportation and disposal requirements. The waste categories used throughout the WMP are those identified in the INEEL Reusable Property, Recyclable Materials, and Waste Acceptance Criteria (RRWAC) document.

2.0 Waste Generation

2.1 Waste Generation Operations

The Phase II Remedial Action includes the construction of three engineered earthen covers. The specific actions are described in detail in the Remedial Design Report/Remedial Action (RD/RA) Work Plan text. In general, covers will be constructed over previously identified soil consolidation sites including the old S1W Leaching Bed/Pit (NRF-14 and NRF-12B), and the A1W Leaching Bed (NRF-19). Additionally, the Old Sewage Basin Site (NRF-21A), which was previously targeted for soil removal, will now be capped. Construction of the engineered earthen covers may entail filling in low areas with clean soil brought to NRF from off-site locations. It will also entail removal of fences, scrubbing the vegetation, and scraping of soil surfaces surrounding the intended construction locations. Soil will be built up over the targeted area to a specified elevation.

During the construction of the covers, wastes may be generated. All waste generated will be characterized as appropriate for hazardous constituents and proper disposal requirements.

2.2 Waste Identification

The wastes that may be generated from the various activities associated with the Phase II Remedial Action are summarized in Table E-1. This table describes the various waste streams and gives estimated volumes for each waste stream.

3.0 Waste Management

The RRWAC discusses the overall strategy for management of wastes generated as a result of the remediation efforts at the INEEL. All wastes will be disposed of in accordance with the requirements identified in the RRWAC and appropriate regulations.

3.1 Characterization

In compliance with the Resource Conservation and Recovery Act (RCRA), a hazardous waste determination must be prepared for all solid wastes. This determination includes a detailed chemical and physical analysis of representative samples of the waste and/or process knowledge. Local NRF procedures provide guidance for completion of hazardous waste determinations. The generation of hazardous waste is not expected during the Phase II Remedial Action.

Table E-1. Waste Description, Stream, and Estimated Volume for the Phase II Remedial Action

Waste Description[a]	Examples	Waste Stream	Estimated Volume
Surface Debris	Asphalt, fence posts, cabling, sprinkler lines, cement blocks, etc.	Industrial	~10,000 ft^3
Personnel Protective Equipment	Non-launderable gloves, booties, overshoes, etc.	LLRW	<20 ft^3
Construction material	Clean tarps, non-recyclable metal, Wood, etc.	Industrial	<50 ft^3
Sampling material	Sample containers, trowels, bottles, etc.	LLRW	<5 ft^3
Tools	Unusable brushes, hammers, shovels, etc.	Industrial	<15 ft^3
Administrative	Paper, etc.	Industrial	<5 ft^3
Monitoring waste	Radiological swipes, filter papers	LLRW	<2 ft^3
Asbestos bearing debris	Surface debris such as old roofing material	Industrial	<50 ft^3
Decontamination Fluid	Water used to rinse sample equipment	Remediation	<10 gallons

(a) Recyclable material is not included on the table since it is not considered a waste. Approximately 10 ft^3 of recyclable material (e.g., clean cardboard, wood, metal) is expected to be generated during the Phase I Remedial Action.

(b) Low Level Radioactive Waste (LLRW) may include potentially contaminated items that do not warrant the effort to prove them uncontaminated.

3.2 Waste Minimization and Segregation

Waste minimization for the Phase II Remedial Action is primarily achieved through design and planning to ensure efficient operation and to prevent unnecessary generation of wastes. The types of waste that are expected to be generated during the remedial action are described in Section 2. These wastes will generally be segregated into the categories defined in Table E-1.

3.3 Waste Disposition

Wastes generated during the Phase II Remedial Action will be dispositioned in accordance with the RRWAC and NRF procedures. Industrial wastes will be recycled at the Industrial Handling and Cubing Facility or disposed of at the INEEL Landfill Complex located at the Central Facilities Area (CFA), following protocols identified in the RRWAC. Solid low-level radioactive waste, if any, will be dispositioned in accordance with the protocols of the RRWAC. Hazardous waste is not expected to be generated; however, in the unlikely event it is, disposition will be in accordance with the RRWAC. Mixed hazardous waste (RCRA hazardous and low-level radioactive) is also not expected, but will be dispositioned according to the INEEL Site Treatment Plan if it is generated. Soil within the affected area may also require evaluation, if a release appears to have been possible.

Prior to any disposal actions, a hazardous waste determination will be performed for each type of waste. A brief description of each waste stream is provided in the following sections. Table

E-1 provided information on the expected waste streams and estimated volumes of each waste stream.

3.3.1 Solid Low-Level Radioactive Waste

This waste will consist primarily of PPE and/or sampling equipment that is contaminated with low-level radioactivity. This waste will be segregated into compactible and non-compactible waste streams. The compactible waste (e.g., some PPE) will be sent to the Waste Reduction Operations Complex for volume reduction prior to disposal at the RWMC. Non-compactible waste will be placed into appropriate containers for shipment to and disposal at the RWMC.

3.3.2 Industrial Waste

Industrial waste will likely be generated during the Phase II Remedial Action. These wastes will include non-radioactive paper products, tarps, equipment, and demolition debris (asphalt). Waste classified as Industrial Waste to be Recycled (e.g., cardboard) will be placed in specified dumpsters. This waste is sent to the Industrial Handling and Cubing Facility to be recycled. The remaining industrial waste, once radiologically released, will be sent to the INEEL Landfill Complex at the CFA.

3.3.3 Remediation Waste

The potential remediation waste may include less than 10 gallons of decontamination fluid that could be generated during the Phase II Remedial Action. Decontamination efforts will primarily involve water used to rinse sampling equipment. The water will be collected pending sample results of the water and confirmatory sample results of the soil in which the sampling was performed. Decontamination rags and swipes are typically used to decontaminate radiological items (i.e., non-sampling material) and freestanding liquid is not usually generated. The decontamination fluids will be sampled for radioactivity, and for hazardous constituents if hazardous debris has been encountered. Hazardous debris is not expected to be encountered during the remedial action. If the water is determined to be only radioactive, it will be reprocessed and reused at NRF per local radiological procedures and is not considered a remediation waste. If the water is not radioactive or hazardous, it will be released to the area where excavation occurred. If hazardous constituents are present in the decontamination fluids, then an alternative disposal path (e.g., Site Treatment Plan) will be necessary.

3.3.4 Recyclable Material

Non-radioactive, non-hazardous waste generated during the Phase II Remedial Action will be recycled when possible. A recycling subcontract is in place for cardboard, wood, and metal. In addition, industrial waste that meets the recycling requirements of the Industrial Handling and Cubing Facility will be sent to that facility.

3.4 Packaging

NRF does not anticipate that hazardous waste will be generated during the Phase II Remedial Action. If hazardous waste is generated, then mixed waste or hazardous waste rules will apply. Otherwise, packaging of the low-level radioactive waste materials will comply with the requirements stated in the RRWAC, the U.S. Department of Transportation (DOT) regulations, and applicable Department of Energy (DOE) orders. Low-level waste will be placed into appropriate containers for volume reduction at the Waste Reduction Operations Complex and/or for disposal at the RWMC.

3.5 Labeling

Radioactive waste is not expected to be encountered or generated; however, if encountered, marking and labeling of low-level radioactive waste containers will be performed in accordance with RRWAC and DOT regulations.

3.6 Storage and Inspection

Since hazardous wastes are not expected to be generated during the Phase II Remedial Action, the RCRA requirements for managing such waste are not expected to be applicable. If hazardous levels of chemicals are determined to be present, appropriate substantive RCRA storage rules will be promptly implemented.

Low-level radioactive waste, if encountered, will be stored in suitable containers and placed in a Radioactive Material Storage Area in accordance with local radiological control requirements. This waste will be temporarily stored onsite until being dispositioned to the RWMC.

3.7 Transportation

Wastes generated as a result of with the Phase II Remedial Action will be transported in accordance with the requirements identified in the RRWAC, applicable DOT regulations, and applicable DOE orders as appropriate.

Appendix F

HELP Model Runs

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1.0 Introduction

Estimates of leachate generation were obtained using the Hydrologic Evaluation of Landfill Performance (HELP) computer model. This model uses a water balance calculation to derive these estimates of leachate generation. The model utilizes climatologic, soil, and design information with a solution that accounts for the effects of surface storage, runoff, infiltration, percolation, evapotranspiration, soil moisture storage, and lateral drainage. The model allows for various combinations of vegetation, cover soils, low-permeability barrier soils, and layers in the landfill cover design, and is applicable to non-landfill engineered covers like those for the OU 8-08 areas.

Two precipitation event scenarios were modeled in order to compare/evaluate a worst case precipitation event and an average precipitation event. The assumptions formulated in running the HELP model are discussed below.

2.0 Climatological Data

The climatological data required for the HELP model are classified into four groups: precipitation, evapotranspiration, temperature, and solar radiation data. For the average precipitation event, available daily precipitation data from 1950 to 2000 for the INEEL Central Facilities Area (CFA), as recorded by the National Oceanic and Atmospheric Administration (NOAA), were utilized. From this fifty year period an average yearly precipitation of 8.68 inches was determined. The maximum precipitation amount used to model the wet precipitation period is double the average annual precipitation value (which yields 17.36 inches) and is nearly the same (16.7 inches) as that used to model the NRF inactive landfill covers (OU 8-05/6; WEC, 1995). Furthermore, this amount is also slightly greater than that used in the INEEL cover study (16.5 inches, Anderson and Foreman, 2002). The maximum annual precipitation (in a calendar year) actually recorded at CFA was 14.4 inches over a period of about 50 years. In addition, a peak day precipitation event was modeled for both average and wet precipitation events. A peak day precipitation event is defined as the maximum amount of precipitation received in inches in one day over the project period (in years) modeled. A ten year simulation time period was used for the hypothetical wet precipitation event, using the average precipitation of 17.36 inches, to calculate the ten year average leachate production. For the average precipitation event (based on an average annual precipitation of 8.68 inches) a 100 year simulation time period was used to calculate the 100 year average leachate production. Available average monthly temperatures from CFA as reported by NOAA were also used for both precipitation cases.

The essential data needed for evapotranspiration are the maximum leaf area index and the evaporative zone depth. The leaf area index is defined as the dimensionless ratio of the leaf area of active transpiring vegetation to the nominal surface area of the land on which the vegetation is growing. The maximum leaf area index of 2.0 was used in the model, which corresponds to an area with fair grass ground cover. The leaf area index value of 2.0 was chosen to model the case when the extent of vegetative growth on the cover is 50% or less over the cover area. The evaporative zone depth is the maximum depth from which water can be removed by evapotranspiration. The evaporative zone depth ranges from a minimum of 48 inches up to 60 inches at the INEEL, according to studies done at locations within the INEEL (EG&G, 1992). Field test plots with native grasses at the INEEL indicate that the effective evaporative zone depth can be as far down to 55 inches (EG&G, 1992). Other field studies have indicated upward hydraulic gradients predominantly above 48 inches. For the modeling of the NRF landfill covers, an evaporative zone depth of 48 inches (the minimum value) was used as a conservative value. Another input parameter required by the model is an average windspeed, which for CFA is 7.2 miles/hour as reported by NOAA.

The model generates daily temperature data stochastically for the number of years of precipitation data entered. Normal mean monthly temperature values for a specific location can be entered to improve the statistical characteristics of the resulting daily values. Normal mean monthly temperature values derived over a 40 year period for the INEEL obtained from NOAA were used for the NRF HELP model runs for the average precipitation period. However, for the wet precipitation period, several sets of mean monthly temperature data over a twelve month period were evaluated from higher than normal precipitation periods (over a consecutive 12 month period but not necessarily over a calendar year) as observed at CFA over a period of 50 years. The consecutive 12 month precipitation ranged between 14 and 15.2 inches for these higher than normal precipitation periods. Of the sets of temperature data evaluated, the set that yielded the lowest annual average temperature was the temperature set that was used in the model for the wet precipitation period. The model calculates solar radiation values stochastically based on temperature and rainfall data. The latitude for NRF of 43.65 degrees was used for the model to more accurately determine solar radiation values for NRF.

3.0 Soil Data

The HELP model defines three types of layers in engineered cover design: vertical percolation, lateral drainage, and barrier soil layers. A vertical percolation layer is defined as a layer of moderate to high permeability material without drainage collection systems. To be conservative for the NRF engineered cover design, the majority of the layers were modeled as vertical percolation layers, with the exception of the biobarrier layer (modeled as a drainage layer without a collection system). The engineered cover design modeled for the NRF 8-08 areas consisted of a five layer configuration: a top layer (or vegetative layer), an underlying subsurface soil layer, a biobarrier layer, a base support/pre-existing soil layer, and a contamination layer. The estimated leachate production would be determined as that amount exiting the bottom of the contamination layer. The top layer for the vegetative cover was assumed to be 6 inches thick with a hydraulic conductivity of 1.0×10^{-4} cm/sec. The subsurface soil layer was assumed to be 4 feet thick with a hydraulic conductivity of 1.0×10^{-5} cm/sec. The base support/pre-existing soil layer was assumed to be an average of 18 inches thick with a hydraulic conductivity of 1.0×10^{-5} cm/sec. Each site was modeled using the site-specific surface area and contamination layer thicknesses. The hydraulic conductivity for the contamination layer was assumed to be 2.0×10^{-2} cm/sec. The contamination layer hydraulic conductivity is typical of a gravel/sandy type soil, which is the type of soil in which the contamination was encountered during the Phase I Remedial Action excavation activities. The hydraulic conductivity for the subsurface soil layer is the value obtained as discussed in the main text (Section 4.1.2); the model assumes that the hydraulic conductivity value of 1.0×10^{-5} cm/sec is consistent throughout. The base support/pre-existing soil hydraulic conductivity is assumed to be equal to or less than 1.0×10^{-5} cm/sec.

The model also requires wilting point, field capacity, initial soil moisture contents, and porosity as input parameters for each layer. Two different sets of initial soil moisture content input values were used in modeling the proposed engineered cover design. The two sets of initial soil moisture values were user-specified values and computer model generated values. The model requires that the initial soil moisture contents be greater than the wilting point. Therefore, these two initial soil moisture cases were modeled as follows:

- The first case used maximum soil moisture contents obtained in the soils that were used in the INEEL ET cover study (Anderson and Foreman, 2002). This case is intended to model approximate actual conditions that may be encountered by the placement of the proposed engineered cover, which is similar in design to the one recommended by the INEEL ET cover study. All user specified soil moisture values were above the wilting point but below the field capacity.

- The second case used model generated soil moisture contents as the initial soil moisture contents to model a steady-state condition.

The initial soil moisture content values calculated by the model can be too high for semi-arid and arid regions (EG&G, 1992 and WEC, 1995). Soil moisture contents near or at field capacity will allow a greater amount of infiltrating water to pass through the base support/pre-existing soil and will, thus, be available for leachate production.

Using the soil data above and entered into the program, the model generates a Soil Conservation Service (SCS) Runoff Curve Number, another soil input parameter used to model the rainfall-runoff process. The initial SCS runoff curve number generated represents an average soil-moisture condition. Adjustments are then made by the model to the initial runoff curve number. The adjustments include corrections for surface slope, soil moisture, and frozen soil.

Additional input parameters are the total surface area for each of the cover areas, the top surface slope, the horizontal drainage distance for the cover, and the initial quantity of water on the surface in the form of ice or snow. The initial water quantity on the surface was calculated by the model derived from the wet precipitation scenario, and was used for both scenarios. It was also assumed that the total surface area of the cover was available for precipitation to run off.

4.0 Model Output

Attached are copies of the summary output for the two precipitation scenarios and for the two initial soil moisture content cases. The estimated leachate quantities generated by the designated area with the proposed engineered cover as predicted by the HELP model for both precipitation scenarios are presented in Table F-1.

For further evaluation purposes on the performance of the cover, summary output for the top three cover layers (of the engineered cover) using only case 2 initial soil moisture values (representing the worst case of the two conditions modeled for the wet period, and a near worst case for the average precipitation period) is presented in Table F-2. These results represent modeling of the water storage capability of the engineered cover only. The three layer summary output gives an indication of how much water infiltrates through the cover before reaching the base layer and contamination layer.

Table F-1 Estimated Leachate Quantities Generated by the Proposed Cover Design using the HELP Model

Site	Average Precipitation Period				Wet Precipitation Period			
	Average Annual[a] Leachate Production (gal/yr)		Peak Day[b] Leachate Production (gal/day)		Average Annual[a] Leachate Production (gal/yr)		Peak Day[b] Leachate Production (gal/day)	
	Initial soil Moisture Case 1[c]	Initial soil Moisture Case 2[d]	Initial soil Moisture Case 1[c]	Initial soil Moisture Case 2[d]	Initial soil Moisture Case 1[c]	Initial soil Moisture Case 2[d,e]	Initial soil Moisture Case 1[c]	Initial soil Moisture Case 2[d]
NRF-19	0	174.9	0	7.27	26.4	411.4	6.5	13.8
NRF-21A	0	441.8	0	18.4	0.42	1667	4.2	31.7
NRF-14 & 12B	0	996	0	41.7	5.8	519.5	5.8	67.3

Notes:

a. Based on annual precipitation
b. Based on *peak day precipitation*
c. Initial soil moisture above the Wilting Point based on actual maximum soil moisture contents detected in the soils for the INEEL ET cover study (case 1)
d. Initial soil moisture model input based on model derived soil moisture values for each layer, modeled for approximating a steady-state condition (case 2)
e. The difference in leachate production between the wet and dry (i.e., "average") precipitation scenarios is due to the length of the simulation period (10 years for the wet versus 100 years for the dry). Leachate production during the 100-year dry scenario initially increases with time, leveling off at about the 30-year point, causing a higher per-year leachate when averaging over the 100-year scenario. The wet precipitation scenario does not reach the higher steady state range (as in the case for the dry scenario); therefore per-year average leachate production is relatively low. Running the wet simulation for 100 years (and attaining steady state) would be unrealistic, because a drastic change in climatic conditions would be required for such a duration.

Table F-2 Estimated Percolation/Infiltration Through the Proposed Cover Design using the HELP Model

Site	Average Precipitation Period		Wet Precipitation Period	
	Annual[a] Infiltration into the Contamination Layer (gal/yr)	Peak Day[b] Infiltration into the Contamination Layer (gal/day)	Annual[a] Infiltration into the Contamination Layer (gal/yr)	Peak Day[b] Infiltration into the Contamination Layer (gal/day)
	Initial soil Moisture Case 2[c]	Initial soil Moisture Case 2[c]	Initial soil Moisture Case 2[c]	Initial soil Moisture Case 2[c]
NRF-19	178.5	0.95	4073	226
NRF-21A	442	2.1	10,605	583
NRF-14, 12B	1028	5.3	25,126	1424

Notes:

a. Based on annual precipitation
b. Based on peak day precipitation
c. Initial soil moisture model input based on model derived soil moisture values for each layer, modeled for approximating a steady-state condition (case 2)

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Attachment 1

HELP Model Input/Output Summary Lists

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                 HELP MODEL VERSION 3.07  (1 November 1997)               **
**                    DEVELOPED BY ENVIRONMENTAL LABORATORY                 **
**                      USAE WATERWAYS EXPERIMENT STATION                   **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\WHI\UNSAT22\data\P600.VHP\_weather1.dat
TEMPERATURE DATA FILE:       C:\WHI\UNSAT22\data\P600.VHP\_weather2.dat
SOLAR RADIATION DATA FILE:   C:\WHI\UNSAT22\data\P600.VHP\_weather3.dat
EVAPOTRANSPIRATION DATA:     C:\WHI\UNSAT22\data\P600.VHP\_weather4.dat
SOIL AND DESIGN DATA FILE:   C:\WHI\UNSAT22\data\P600.VHP\I_386275.inp
OUTPUT DATA FILE:            C:\WHI\UNSAT22\data\P600.VHP\O_386275.prt


TIME:  19:33     DATE:   6/18/2002


******************************************************************************

     TITLE:  Evap/Biobarrier (14&12B) profile1

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
             WERE SPECIFIED BY THE USER.
```

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 7

```
THICKNESS                   =     15.24   CM
POROSITY                    =      0.4730 VOL/VOL
FIELD CAPACITY              =      0.2220 VOL/VOL
WILTING POINT               =      0.1040 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.1500 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000000000E-03 CM/SEC
NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
       FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 9

```
THICKNESS                   =    121.92   CM
POROSITY                    =      0.5000 VOL/VOL
FIELD CAPACITY              =      0.2840 VOL/VOL
WILTING POINT               =      0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2150 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.120000000000E-04 CM/SEC
```

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

```
THICKNESS                   =     45.72   CM
POROSITY                    =      0.3970 VOL/VOL
FIELD CAPACITY              =      0.0320 VOL/VOL
WILTING POINT               =      0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0270 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.300000000000E-02 CM/SEC
SLOPE                       =      0.00   PERCENT
DRAINAGE LENGTH             =  10000.0    METERS
```

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 10

```
THICKNESS                   =      3.05   CM
POROSITY                    =      0.4370 VOL/VOL
FIELD CAPACITY              =      0.1050 VOL/VOL
WILTING POINT               =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.4370 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.170000000000E-02 CM/SEC
```

```
                        LAYER  5
                        --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER   4
THICKNESS                  =     60.96    CM
POROSITY                   =       0.4370 VOL/VOL
FIELD CAPACITY             =       0.1050 VOL/VOL
WILTING POINT              =       0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT =       0.1000 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.170000000000E-02 CM/SEC


                        LAYER  6
                        --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER   4
THICKNESS                  =    883.92    CM
POROSITY                   =       0.4370 VOL/VOL
FIELD CAPACITY             =       0.1050 VOL/VOL
WILTING POINT              =       0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT =       0.1000 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.200000000000E-01 CM/SEC


           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
          SOIL DATA BASE USING SOIL TEXTURE # 7 WITH A
          FAIR STAND OF GRASS, A SURFACE SLOPE OF  3.%
          AND A SLOPE LENGTH OF   61. METERS.

SCS RUNOFF CURVE NUMBER            =      75.44
FRACTION OF AREA ALLOWING RUNOFF   =     100.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =       1.4164 HECTARES
EVAPORATIVE ZONE DEPTH             =      81.3    CM
INITIAL WATER IN EVAPORATIVE ZONE  =      16.485  CM
UPPER LIMIT OF EVAPORATIVE STORAGE =      40.229  CM
LOWER LIMIT OF EVAPORATIVE STORAGE =      10.831  CM
INITIAL SNOW WATER                 =       0.000  CM
INITIAL WATER IN LAYER MATERIALS   =     125.553  CM
TOTAL INITIAL WATER                =     125.553  CM
TOTAL SUBSURFACE INFLOW            =       0.00   MM/YR


             EVAPOTRANSPIRATION AND WEATHER DATA
             -----------------------------------

 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          INEEL/NRF OU 8-08 SitesID
```

```
STATION LATITUDE                         = 43.63 DEGREES
MAXIMUM LEAF AREA INDEX                  =  2.00
START OF GROWING SEASON (JULIAN DATE)    =   132
END OF GROWING SEASON (JULIAN DATE)      =   275
EVAPORATIVE ZONE DEPTH                   = 48.0  INCHES
AVERAGE ANNUAL WIND SPEED                =  7.20 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY    = 65.30 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY    = 42.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY    = 33.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY    = 58.60 %
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.70	0.63	0.62	0.72	1.24	1.22
0.50	0.53	0.65	0.50	0.65	0.70

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
16.10	21.70	30.50	41.60	51.20	60.00
68.00	66.00	55.50	44.00	29.90	18.70

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID AND STATION LATITUDE = 43.63 DEGREES

****

MONTHLY TOTALS (IN INCHES) FOR YEAR 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.72	0.86	1.12	0.91	3.11	1.03
	1.41	1.01	1.65	0.27	0.24	0.20
RUNOFF	0.000	0.092	0.213	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.403	0.587	0.505	1.084	2.334	2.285
	3.260	1.062	0.701	0.517	0.216	0.200
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

```
PERCOLATION/LEAKAGE THROUGH      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  4                       0.0000  0.0000  0.0000  0.0000  0.0000  0.0000

PERCOLATION/LEAKAGE THROUGH      0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
  LAYER  6                       0.0000  0.0000  0.0000  0.0000  0.0000  0.0000


-------------------------------------------------------------------------------
                 MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


AVERAGE DAILY HEAD ON            0.000   0.000   0.000   0.000   0.000   0.000
  TOP OF LAYER  4                0.000   0.000   0.000   0.000   0.000   0.000

STD. DEVIATION OF DAILY          0.000   0.000   0.000   0.000   0.000   0.000
  HEAD ON TOP OF LAYER  4        0.000   0.000   0.000   0.000   0.000   0.000

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                     ANNUAL TOTALS FOR YEAR  100
-------------------------------------------------------------------------------
                                        INCHES        CU. FEET      PERCENT
                                       --------      ----------     -------
  PRECIPITATION                          13.53      171894.903     100.00

  RUNOFF                                  0.306       3882.940       2.26

  EVAPOTRANSPIRATION                     13.154     167115.457      97.22

  DRAINAGE COLLECTED FROM LAYER  3        0.0000         0.000       0.00

  PERC./LEAKAGE THROUGH LAYER  4          0.000000       0.000       0.00

  AVG. HEAD ON TOP OF LAYER  4            0.0000

  PERC./LEAKAGE THROUGH LAYER  6          0.000000       0.000       0.00

  CHANGE IN WATER STORAGE                 0.071        896.509       0.52

  SOIL WATER AT START OF YEAR            48.994     622461.176

  SOIL WATER AT END OF YEAR              49.280     626083.968

  SNOW WATER AT START OF YEAR             0.215       2726.283       1.59

  SNOW WATER AT END OF YEAR               0.000          0.000       0.00

  ANNUAL WATER BUDGET BALANCE             0.0000        -0.003       0.00

*******************************************************************************
```

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.75	0.69	0.62	0.69	1.17	1.23
	0.53	0.54	0.56	0.44	0.64	0.72
STD. DEVIATIONS	0.32	0.32	0.27	0.30	0.68	0.78
	0.40	0.43	0.50	0.32	0.31	0.31
RUNOFF						
TOTALS	0.000	0.013	0.042	0.002	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.029	0.102	0.006	0.000	0.001
	0.000	0.000	0.000	0.000	0.001	0.000
EVAPOTRANSPIRATION						
TOTALS	0.496	0.519	0.472	0.984	1.260	1.572
	1.080	0.509	0.423	0.366	0.353	0.506
STD. DEVIATIONS	0.102	0.109	0.159	0.297	0.497	0.604
	0.686	0.396	0.340	0.194	0.135	0.139
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 6						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

****

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	INCHES		CU. FEET	PERCENT
PRECIPITATION	8.60	(1.649)	109207.3	100.00
RUNOFF	0.057	(0.1109)	727.44	0.666
EVAPOTRANSPIRATION	8.540	(1.4949)	108498.97	99.351
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.00000	(0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00000	(0.00000)	0.000	0.00000
AVERAGE HEAD ON TOP OF LAYER 4	0.000	(0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000	(0.00000)	0.000	0.00000
CHANGE IN WATER STORAGE	-0.002	(0.6280)	-19.15	-0.018

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 100 and their dates (DDDYYYY

	(INCHES)	(CU. FT.)	
PRECIPITATION	1.94	24647.16278	1550045
RUNOFF	0.396	5036.22167	810093
DRAINAGE COLLECTED FROM LAYER 3	0.00000	0.00000	0
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000000	0.00000	0
AVERAGE HEAD ON TOP OF LAYER 4	0.000		
MAXIMUM HEAD ON TOP OF LAYER 4	0.000		
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00000	0

SNOW WATER	2.28	29018.6905	480036

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.2529

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1332

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(INCHES)	(VOL/VOL)
1	1.1745	0.1958
2	9.8555	0.2053
3	0.5252	0.0292
4	0.5244	0.4370
5	2.4000	0.1000
6	34.8000	0.1000
SNOW WATER	0.000	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07 (1 November 1997)                 **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
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PRECIPITATION DATA FILE:     C:\WHI\UNSAT22\data\P600.VHP\_weather1.dat

TEMPERATURE DATA FILE:       C:\WHI\UNSAT22\data\P600.VHP\_weather2.dat

SOLAR RADIATION DATA FILE:   C:\WHI\UNSAT22\data\P600.VHP\_weather3.dat

EVAPOTRANSPIRATION DATA:     C:\WHI\UNSAT22\data\P600.VHP\_weather4.dat

SOIL AND DESIGN DATA FILE:   C:\WHI\UNSAT22\data\P600.VHP\I_386294.inp

OUTPUT DATA FILE:            C:\WHI\UNSAT22\data\P600.VHP\O_386294.prt


TIME:  19:33     DATE:   6/18/2002


******************************************************************************

     TITLE:  Evap/Biobarrier (21A) profile 1

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.
```

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 7

```
THICKNESS                  =     15.24    CM
POROSITY                   =       0.4730 VOL/VOL
FIELD CAPACITY             =       0.2220 VOL/VOL
WILTING POINT              =       0.1040 VOL/VOL
INITIAL SOIL WATER CONTENT =       0.1500 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000000000E-03 CM/SEC
NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
        FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 9

```
THICKNESS                  =    121.92    CM
POROSITY                   =       0.5000 VOL/VOL
FIELD CAPACITY             =       0.2840 VOL/VOL
WILTING POINT              =       0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT =       0.2150 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.120000000000E-04 CM/SEC
```

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

```
THICKNESS                  =     45.72    CM
POROSITY                   =       0.3970 VOL/VOL
FIELD CAPACITY             =       0.0320 VOL/VOL
WILTING POINT              =       0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT =       0.0270 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.300000000000E-02 CM/SEC
SLOPE                      =       0.00   PERCENT
DRAINAGE LENGTH            =  10000.0     METERS
```

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 10

```
THICKNESS                  =      3.05    CM
POROSITY                   =       0.4370 VOL/VOL
FIELD CAPACITY             =       0.1100 VOL/VOL
WILTING POINT              =       0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT =       0.4370 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.170000000000E-02 CM/SEC
```

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 4

THICKNESS	=	91.44 CM
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.1050 VOL/VOL
WILTING POINT	=	0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1000 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.170000000000E-02 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 4

THICKNESS	=	426.72 CM
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.1050 VOL/VOL
WILTING POINT	=	0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1000 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.200000000000E-01 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 7 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 3.% AND A SLOPE LENGTH OF 21. METERS.

SCS RUNOFF CURVE NUMBER	=	76.97	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	0.6070	HECTARES
EVAPORATIVE ZONE DEPTH	=	81.3	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	16.485	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	40.229	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	10.831	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	82.881	CM
TOTAL INITIAL WATER	=	82.881	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM INEEL/NRF OU 8-08 SitesID

STATION LATITUDE	=	43.63 DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	132
END OF GROWING SEASON (JULIAN DATE)	=	275
EVAPORATIVE ZONE DEPTH	=	48.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.20 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	65.30 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	42.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	33.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	58.60 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.70	0.63	0.62	0.72	1.24	1.22
0.50	0.53	0.65	0.50	0.65	0.70

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
16.10	21.70	30.50	41.60	51.20	60.00
68.00	66.00	55.50	44.00	29.90	18.70

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID
AND STATION LATITUDE = 43.63 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.72	0.86	1.12	0.91	3.11	1.03
	1.41	1.01	1.65	0.27	0.24	0.20
RUNOFF	0.000	0.092	0.213	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.403	0.587	0.505	1.084	2.334	2.285
	3.260	1.062	0.701	0.517	0.216	0.200
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 100

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.53	73669.244	100.00
RUNOFF	0.306	1664.117	2.26
EVAPOTRANSPIRATION	13.154	71620.910	97.22
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 4	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0000		
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
CHANGE IN WATER STORAGE	0.071	384.218	0.52
SOIL WATER AT START OF YEAR	32.197	175309.554	
SOIL WATER AT END OF YEAR	32.482	176862.179	
SNOW WATER AT START OF YEAR	0.215	1168.407	1.59
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.001	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.75	0.69	0.62	0.69	1.17	1.23
	0.53	0.54	0.56	0.44	0.64	0.72
STD. DEVIATIONS	0.32	0.32	0.27	0.30	0.68	0.78
	0.40	0.43	0.50	0.32	0.31	0.31
RUNOFF						
TOTALS	0.000	0.013	0.042	0.002	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.029	0.102	0.006	0.000	0.003
	0.000	0.000	0.000	0.000	0.001	0.000
EVAPOTRANSPIRATION						
TOTALS	0.496	0.519	0.472	0.984	1.259	1.572
	1.080	0.509	0.423	0.366	0.353	0.506
STD. DEVIATIONS	0.102	0.109	0.159	0.297	0.497	0.604
	0.686	0.396	0.340	0.194	0.135	0.139
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 6						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	INCHES		CU. FEET	PERCENT
PRECIPITATION	8.60	(1.649)	46803.1	100.00
RUNOFF	0.057	(0.1110)	312.51	0.668
EVAPOTRANSPIRATION	8.540	(1.4948)	46498.66	99.350
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.00000	(0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00000	(0.00000)	0.000	0.00000
AVERAGE HEAD ON TOP OF LAYER 4	0.000	(0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000	(0.00000)	0.000	0.00000
CHANGE IN WATER STORAGE	-0.001	(0.6277)	-8.06	-0.017

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100 and their dates (DDDYYYY

	(INCHES)	(CU. FT.)	
PRECIPITATION	1.94	10563.06976	1550045
RUNOFF	0.396	2158.38072	810093
DRAINAGE COLLECTED FROM LAYER 3	0.00000	0.00000	0
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000000	0.00000	0
AVERAGE HEAD ON TOP OF LAYER 4	0.000		
MAXIMUM HEAD ON TOP OF LAYER 4	0.000		
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00000	0

SNOW WATER	2.28	12436.5816	480036

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.2529

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1332

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(INCHES)	(VOL/VOL)
1	1.1745	0.1958
2	9.8579	0.2054
3	0.5255	0.0292
4	0.5244	0.4370
5	3.6000	0.1000
6	16.8000	0.1000
SNOW WATER	0.000	

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 November 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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```

PRECIPITATION DATA FILE: C:\WHI\UNSAT22\data\P600.VHP_weather1.dat

TEMPERATURE DATA FILE: C:\WHI\UNSAT22\data\P600.VHP_weather2.dat

SOLAR RADIATION DATA FILE: C:\WHI\UNSAT22\data\P600.VHP_weather3.dat

EVAPOTRANSPIRATION DATA: C:\WHI\UNSAT22\data\P600.VHP_weather4.dat

SOIL AND DESIGN DATA FILE: C:\WHI\UNSAT22\data\P600.VHP\I_386313.inp

OUTPUT DATA FILE: C:\WHI\UNSAT22\data\P600.VHP\O_386313.prt

TIME: 19:33   DATE: 6/18/2002

****

TITLE: Evap/Biobarrier (19) profile1

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NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
WERE SPECIFIED BY THE USER.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 7

```
THICKNESS                    =      15.24    CM
POROSITY                     =        0.4730 VOL/VOL
FIELD CAPACITY               =        0.2220 VOL/VOL
WILTING POINT                =        0.1040 VOL/VOL
INITIAL SOIL WATER CONTENT   =        0.1500 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =   0.100000000000E-03 CM/SEC
NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
         FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 9

```
THICKNESS                    =     121.92    CM
POROSITY                     =        0.5000 VOL/VOL
FIELD CAPACITY               =        0.2840 VOL/VOL
WILTING POINT                =        0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT   =        0.2150 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =   0.120000000000E-04 CM/SEC
```

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

```
THICKNESS                    =      45.72    CM
POROSITY                     =        0.3970 VOL/VOL
FIELD CAPACITY               =        0.0320 VOL/VOL
WILTING POINT                =        0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT   =        0.0270 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =   0.300000000000E-02 CM/SEC
SLOPE                        =        0.00   PERCENT
DRAINAGE LENGTH              =   10000.0     METERS
```

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 10

```
THICKNESS                    =        3.05   CM
POROSITY                     =        0.4370 VOL/VOL
FIELD CAPACITY               =        0.1100 VOL/VOL
WILTING POINT                =        0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT   =        0.4370 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =   0.170000000000E-02 CM/SEC
```

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 4

```
THICKNESS                    =    30.48   CM
POROSITY                     =     0.4370 VOL/VOL
FIELD CAPACITY               =     0.1050 VOL/VOL
WILTING POINT                =     0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT   =     0.1000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.170000000000E-02 CM/SEC
```

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 4

```
THICKNESS                    =   457.20   CM
POROSITY                     =     0.4370 VOL/VOL
FIELD CAPACITY               =     0.1050 VOL/VOL
WILTING POINT                =     0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT   =     0.1000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.200000000000E-01 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
SOIL DATA BASE USING SOIL TEXTURE # 7 WITH A
FAIR STAND OF GRASS, A SURFACE SLOPE OF 3.%
AND A SLOPE LENGTH OF 11. METERS.

```
SCS RUNOFF CURVE NUMBER              =     77.92
FRACTION OF AREA ALLOWING RUNOFF     =    100.0     PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =      0.2428  HECTARES
EVAPORATIVE ZONE DEPTH               =     81.3     CM
INITIAL WATER IN EVAPORATIVE ZONE    =     16.485   CM
UPPER LIMIT OF EVAPORATIVE STORAGE   =     40.229   CM
LOWER LIMIT OF EVAPORATIVE STORAGE   =     10.831   CM
INITIAL SNOW WATER                   =      0.000   CM
INITIAL WATER IN LAYER MATERIALS     =     79.833   CM
TOTAL INITIAL WATER                  =     79.833   CM
TOTAL SUBSURFACE INFLOW              =      0.00    MM/YR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
INEEL/NRF OU 8-08 SitesID

STATION LATITUDE	=	43.63 DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	132
END OF GROWING SEASON (JULIAN DATE)	=	275
EVAPORATIVE ZONE DEPTH	=	48.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.20 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	65.30 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	42.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	33.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	58.60 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.70	0.63	0.62	0.72	1.24	1.22
0.50	0.53	0.65	0.50	0.65	0.70

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
16.10	21.70	30.50	41.60	51.20	60.00
68.00	66.00	55.50	44.00	29.90	18.70

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID AND STATION LATITUDE = 43.63 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.72	0.86	1.12	0.91	3.11	1.03
	1.41	1.01	1.65	0.27	0.24	0.20
RUNOFF	0.000	0.092	0.213	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.403	0.587	0.505	1.084	2.334	2.285
	3.260	1.062	0.701	0.517	0.216	0.200
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 100

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.53	29467.698	100.00
RUNOFF	0.306	665.647	2.26
EVAPOTRANSPIRATION	13.154	28648.364	97.22
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 4	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0000		
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
CHANGE IN WATER STORAGE	0.071	153.687	0.52
SOIL WATER AT START OF YEAR	31.009	67535.070	
SOIL WATER AT END OF YEAR	31.294	68156.121	
SNOW WATER AT START OF YEAR	0.215	467.363	1.59
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.000	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.75	0.69	0.62	0.69	1.17	1.23
	0.53	0.54	0.56	0.44	0.64	0.72
STD. DEVIATIONS	0.32	0.32	0.27	0.30	0.68	0.78
	0.40	0.43	0.50	0.32	0.31	0.31
RUNOFF						
TOTALS	0.000	0.013	0.042	0.002	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.029	0.102	0.006	0.000	0.004
	0.000	0.000	0.000	0.000	0.001	0.000
EVAPOTRANSPIRATION						
TOTALS	0.496	0.519	0.472	0.984	1.259	1.572
	1.080	0.509	0.423	0.366	0.353	0.506
STD. DEVIATIONS	0.102	0.109	0.159	0.297	0.497	0.604
	0.686	0.396	0.340	0.194	0.135	0.139
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 6						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	INCHES		CU. FEET	PERCENT
PRECIPITATION	8.60	(1.649)	18721.2	100.00
RUNOFF	0.058	(0.1111)	125.26	0.669
EVAPOTRANSPIRATION	8.540	(1.4943)	18598.96	99.347
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.00000	(0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00000	(0.00000)	0.000	0.00000
AVERAGE HEAD ON TOP OF LAYER 4	0.000	(0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000	(0.00000)	0.000	0.00000
CHANGE IN WATER STORAGE	-0.001	(0.6278)	-2.98	-0.016

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100 and their dates (DDDYYYY

	(INCHES)	(CU. FT.)	
PRECIPITATION	1.94	4225.22791	1550045
RUNOFF	0.396	863.35229	810093
DRAINAGE COLLECTED FROM LAYER 3	0.00000	0.00000	0
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000000	0.00000	0
AVERAGE HEAD ON TOP OF LAYER 4	0.000		
MAXIMUM HEAD ON TOP OF LAYER 4	0.000		
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00000	0

SNOW WATER	2.28	4974.6327	480036

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.2529

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1332

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(INCHES)	(VOL/VOL)
1	1.1745	0.1958
2	9.8682	0.2056
3	0.5265	0.0293
4	0.5244	0.4370
5	1.2000	0.1000
6	18.0000	0.1000
SNOW WATER	0.000	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07 (1 November 1997)                 **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
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PRECIPITATION DATA FILE:    C:\WHI\UNSAT22\data\P584.VHP\_weather1.dat

TEMPERATURE DATA FILE:      C:\WHI\UNSAT22\data\P584.VHP\_weather2.dat

SOLAR RADIATION DATA FILE:  C:\WHI\UNSAT22\data\P584.VHP\_weather3.dat

EVAPOTRANSPIRATION DATA:    C:\WHI\UNSAT22\data\P584.VHP\_weather4.dat

SOIL AND DESIGN DATA FILE:  C:\WHI\UNSAT22\data\P584.VHP\I_386218.inp

OUTPUT DATA FILE:           C:\WHI\UNSAT22\data\P584.VHP\O_386218.prt


TIME:  19:21     DATE:   6/18/2002


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     TITLE:  Evap/Biobarrier (14&12B) profile1

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.
```

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 7

THICKNESS	=	15.24 CM
POROSITY	=	0.4730 VOL/VOL
FIELD CAPACITY	=	0.2220 VOL/VOL
WILTING POINT	=	0.1040 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2075 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000000000E-03 CM/SEC

NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 3.00
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 9

THICKNESS	=	121.92 CM
POROSITY	=	0.5000 VOL/VOL
FIELD CAPACITY	=	0.2840 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2057 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.120000000000E-04 CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	45.72 CM
POROSITY	=	0.3970 VOL/VOL
FIELD CAPACITY	=	0.0320 VOL/VOL
WILTING POINT	=	0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0322 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000000000E-02 CM/SEC
SLOPE	=	0.00 PERCENT
DRAINAGE LENGTH	=	10000.0 METERS

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 10

THICKNESS	=	3.05 CM
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.1100 VOL/VOL
WILTING POINT	=	0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4370 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.170000000000E-02 CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 4

THICKNESS	=	60.96 CM
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.1050 VOL/VOL
WILTING POINT	=	0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1050 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.170000000000E-02 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 4

THICKNESS	=	883.92 CM
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.1050 VOL/VOL
WILTING POINT	=	0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1050 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.200000000000E-01 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 7 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 3.% AND A SLOPE LENGTH OF 61. METERS.

SCS RUNOFF CURVE NUMBER	=	75.44	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.4164	HECTARES
EVAPORATIVE ZONE DEPTH	=	81.3	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	12.372	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	40.229	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	10.831	CM
INITIAL SNOW WATER	=	0.155	CM
INITIAL WATER IN LAYER MATERIALS	=	130.258	CM
TOTAL INITIAL WATER	=	130.413	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM INEEL/NRF OU 8-08 SitesID

STATION LATITUDE	=	43.63 DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	132
END OF GROWING SEASON (JULIAN DATE)	=	275
EVAPORATIVE ZONE DEPTH	=	48.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.20 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	65.30 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	42.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	33.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	58.60 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.70	0.63	0.62	0.72	1.24	1.22
0.50	0.53	0.65	0.50	0.65	0.70

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
16.10	21.70	30.50	41.60	51.20	60.00
68.00	66.00	55.50	44.00	29.90	18.70

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID AND STATION LATITUDE = 43.63 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.72	0.86	1.12	0.91	3.11	1.03
	1.41	1.01	1.65	0.27	0.24	0.20
RUNOFF	0.000	0.092	0.213	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.403	0.587	0.505	1.084	2.334	2.285
	3.260	1.062	0.701	0.517	0.216	0.200
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH	0.0013	0.0012	0.0013	0.0011	0.0012	0.0008
LAYER 4	0.0011	0.0012	0.0012	0.0012	0.0013	0.0013
PERCOLATION/LEAKAGE THROUGH	0.0014	0.0003	0.0010	0.0007	0.0010	0.0005
LAYER 6	0.0010	0.0007	0.0012	0.0011	0.0008	0.0011

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 100

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.53	171894.903	100.00
RUNOFF	0.306	3882.940	2.26
EVAPOTRANSPIRATION	13.154	167115.457	97.22
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 4	0.014111	179.274	0.10
AVG. HEAD ON TOP OF LAYER 4	0.0000		
PERC./LEAKAGE THROUGH LAYER 6	0.010836	137.668	0.08
CHANGE IN WATER STORAGE	0.060	758.841	0.44
SOIL WATER AT START OF YEAR	51.409	653139.694	
SOIL WATER AT END OF YEAR	51.684	656624.819	
SNOW WATER AT START OF YEAR	0.215	2726.283	1.59
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.003	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.75	0.69	0.62	0.69	1.17	1.23
	0.53	0.54	0.56	0.44	0.64	0.72
STD. DEVIATIONS	0.32	0.32	0.27	0.30	0.68	0.78
	0.40	0.43	0.50	0.32	0.31	0.31
RUNOFF						
TOTALS	0.000	0.013	0.042	0.002	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.029	0.102	0.006	0.000	0.001
	0.000	0.000	0.000	0.000	0.001	0.000
EVAPOTRANSPIRATION						
TOTALS	0.496	0.519	0.473	0.979	1.263	1.565
	1.076	0.510	0.421	0.364	0.353	0.505
STD. DEVIATIONS	0.100	0.109	0.159	0.297	0.490	0.604
	0.687	0.399	0.333	0.188	0.135	0.139
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0010	0.0009	0.0010	0.0009	0.0008	0.0007
	0.0008	0.0009	0.0009	0.0010	0.0010	0.0010
STD. DEVIATIONS	0.0004	0.0003	0.0004	0.0003	0.0003	0.0003
	0.0003	0.0004	0.0003	0.0004	0.0004	0.0004
PERCOLATION/LEAKAGE THROUGH LAYER 6						
TOTALS	0.0010	0.0008	0.0009	0.0008	0.0008	0.0007
	0.0008	0.0009	0.0009	0.0010	0.0009	0.0009
STD. DEVIATIONS	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004
	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.60 (1.649)	109207.3	100.00
RUNOFF	0.057 (0.1109)	727.90	0.667
EVAPOTRANSPIRATION	8.525 (1.5075)	108303.06	99.172
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.00000 (0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.01082 (0.00407)	137.414	0.12583
AVERAGE HEAD ON TOP OF LAYER 4	0.000 (0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.01048 (0.00393)	133.148	0.12192
CHANGE IN WATER STORAGE	0.003 (0.6106)	43.15	0.040

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100 and their dates (DDDYYYY

	(INCHES)	(CU. FT.)	
PRECIPITATION	1.94	24647.16278	1550045
RUNOFF	0.396	5036.22167	810093
DRAINAGE COLLECTED FROM LAYER 3	0.00000	0.00000	0
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000056	0.70595	2600045
AVERAGE HEAD ON TOP OF LAYER 4	0.000		
MAXIMUM HEAD ON TOP OF LAYER 4	0.000		
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000438	5.56870	3040052

SNOW WATER	2.28	29018.6905	480036

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.2529

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1332

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(INCHES)	(VOL/VOL)
1	1.1745	0.1958
2	10.0751	0.2099
3	0.8160	0.0453
4	0.5244	0.4370
5	2.5537	0.1064
6	36.5398	0.1050
SNOW WATER	0.000	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07 (1 November 1997)                 **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
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PRECIPITATION DATA FILE: C:\WHI\UNSAT22\data\P584.VHP_weather1.dat

TEMPERATURE DATA FILE: C:\WHI\UNSAT22\data\P584.VHP_weather2.dat

SOLAR RADIATION DATA FILE: C:\WHI\UNSAT22\data\P584.VHP_weather3.dat

EVAPOTRANSPIRATION DATA: C:\WHI\UNSAT22\data\P584.VHP_weather4.dat

SOIL AND DESIGN DATA FILE: C:\WHI\UNSAT22\data\P584.VHP\I_386237.inp

OUTPUT DATA FILE: C:\WHI\UNSAT22\data\P584.VHP\O_386237.prt

TIME: 19:21   DATE: 6/18/2002

****

TITLE: Evap/Biobarrier (21A) profile 1

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NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 7

```
THICKNESS                  =    15.24   CM
POROSITY                   =     0.4730 VOL/VOL
FIELD CAPACITY             =     0.2220 VOL/VOL
WILTING POINT              =     0.1040 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.2075 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.100000000000E-03 CM/SEC
NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
       FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
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LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 9

```
THICKNESS                  =   121.92   CM
POROSITY                   =     0.5000 VOL/VOL
FIELD CAPACITY             =     0.2840 VOL/VOL
WILTING POINT              =     0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.2057 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.120000000000E-04 CM/SEC
```

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

```
THICKNESS                  =    45.72   CM
POROSITY                   =     0.3970 VOL/VOL
FIELD CAPACITY             =     0.0320 VOL/VOL
WILTING POINT              =     0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.0322 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.300000000000E-02 CM/SEC
SLOPE                      =     0.00   PERCENT
DRAINAGE LENGTH            = 10000.0    METERS
```

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 10

```
THICKNESS                  =     3.05   CM
POROSITY                   =     0.4370 VOL/VOL
FIELD CAPACITY             =     0.1100 VOL/VOL
WILTING POINT              =     0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.4370 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.170000000000E-02 CM/SEC
```

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 8

THICKNESS	=	91.44 CM
POROSITY	=	0.4630 VOL/VOL
FIELD CAPACITY	=	0.2320 VOL/VOL
WILTING POINT	=	0.1160 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2320 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000000000E-03 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 4

THICKNESS	=	426.72 CM
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.1050 VOL/VOL
WILTING POINT	=	0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1050 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.200000000000E-01 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 7 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 3.% AND A SLOPE LENGTH OF 21. METERS.

SCS RUNOFF CURVE NUMBER	=	76.97	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	0.6070	HECTARES
EVAPORATIVE ZONE DEPTH	=	81.3	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	12.372	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	40.229	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	10.831	CM
INITIAL SNOW WATER	=	0.155	CM
INITIAL WATER IN LAYER MATERIALS	=	97.065	CM
TOTAL INITIAL WATER	=	97.221	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM INEEL/NRF OU 8-08 SitesID

```
STATION LATITUDE                          =  43.63 DEGREES
MAXIMUM LEAF AREA INDEX                   =   2.00
START OF GROWING SEASON (JULIAN DATE)     =    132
END OF GROWING SEASON (JULIAN DATE)       =    275
EVAPORATIVE ZONE DEPTH                    =  48.0  INCHES
AVERAGE ANNUAL WIND SPEED                 =   7.20 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY     =  65.30 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY     =  42.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY     =  33.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY     =  58.60 %
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.70	0.63	0.62	0.72	1.24	1.22
0.50	0.53	0.65	0.50	0.65	0.70

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
16.10	21.70	30.50	41.60	51.20	60.00
68.00	66.00	55.50	44.00	29.90	18.70

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID AND STATION LATITUDE = 43.63 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.72	0.86	1.12	0.91	3.11	1.03
	1.41	1.01	1.65	0.27	0.24	0.20
RUNOFF	0.000	0.092	0.213	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.403	0.587	0.505	1.084	2.334	2.285
	3.260	1.062	0.701	0.517	0.216	0.200
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH	0.0013	0.0012	0.0013	0.0011	0.0012	0.0008
LAYER 4	0.0011	0.0012	0.0012	0.0012	0.0013	0.0013
PERCOLATION/LEAKAGE THROUGH	0.0011	0.0011	0.0014	0.0014	0.0012	0.0005
LAYER 6	0.0012	0.0014	0.0009	0.0015	0.0012	0.0014

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 100

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.53	73669.244	100.00
RUNOFF	0.306	1664.117	2.26
EVAPOTRANSPIRATION	13.154	71620.910	97.22
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 4	0.014111	76.832	0.10
AVG. HEAD ON TOP OF LAYER 4	0.0000		
PERC./LEAKAGE THROUGH LAYER 6	0.014247	77.574	0.11
CHANGE IN WATER STORAGE	0.056	306.644	0.42
SOIL WATER AT START OF YEAR	38.311	208597.012	
SOIL WATER AT END OF YEAR	38.582	210072.064	
SNOW WATER AT START OF YEAR	0.215	1168.407	1.59
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.001	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.75	0.69	0.62	0.69	1.17	1.23
	0.53	0.54	0.56	0.44	0.64	0.72
STD. DEVIATIONS	0.32	0.32	0.27	0.30	0.68	0.78
	0.40	0.43	0.50	0.32	0.31	0.31
RUNOFF						
TOTALS	0.000	0.013	0.042	0.002	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.029	0.102	0.006	0.000	0.003
	0.000	0.000	0.000	0.000	0.001	0.000
EVAPOTRANSPIRATION						
TOTALS	0.496	0.519	0.473	0.979	1.263	1.565
	1.076	0.510	0.421	0.364	0.353	0.505
STD. DEVIATIONS	0.100	0.109	0.159	0.297	0.490	0.604
	0.687	0.399	0.333	0.188	0.135	0.139
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0010	0.0009	0.0010	0.0009	0.0008	0.0007
	0.0008	0.0009	0.0009	0.0010	0.0010	0.0010
STD. DEVIATIONS	0.0004	0.0003	0.0004	0.0003	0.0003	0.0003
	0.0003	0.0004	0.0003	0.0004	0.0004	0.0004
PERCOLATION/LEAKAGE THROUGH LAYER 6						
TOTALS	0.0010	0.0009	0.0009	0.0010	0.0008	0.0007
	0.0008	0.0009	0.0009	0.0009	0.0010	0.0010
STD. DEVIATIONS	0.0004	0.0004	0.0004	0.0004	0.0005	0.0004
	0.0004	0.0004	0.0005	0.0005	0.0005	0.0005

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.60 (1.649)	46803.1	100.00
RUNOFF	0.057 (0.1110)	312.71	0.668
EVAPOTRANSPIRATION	8.524 (1.5074)	46414.70	99.170
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.00000 (0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.01084 (0.00407)	59.037	0.12614
AVERAGE HEAD ON TOP OF LAYER 4	0.000 (0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.01085 (0.00407)	59.057	0.12618
CHANGE IN WATER STORAGE	0.003 (0.6104)	16.65	0.036

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100 and their dates (DDDYYYY

	(INCHES)	(CU. FT.)	
PRECIPITATION	1.94	10563.06976	1550045
RUNOFF	0.396	2158.38072	810093
DRAINAGE COLLECTED FROM LAYER 3	0.00000	0.00000	0
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000051	0.28033	2790096
AVERAGE HEAD ON TOP OF LAYER 4	0.000		
MAXIMUM HEAD ON TOP OF LAYER 4	0.000		
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000452	2.46042	870035

SNOW WATER	2.28	12436.5816	480036

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.2529

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1332

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(INCHES)	(VOL/VOL)
1	1.1745	0.1958
2	10.0751	0.2099
3	0.8160	0.0453
4	0.5244	0.4370
5	8.3518	0.2320
6	17.6397	0.1050
SNOW WATER	0.000	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**               HELP MODEL VERSION 3.07 (1 November 1997)                  **
**                DEVELOPED BY ENVIRONMENTAL LABORATORY                     **
**                  USAE WATERWAYS EXPERIMENT STATION                       **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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```

PRECIPITATION DATA FILE: C:\WHI\UNSAT22\data\P584.VHP_weather1.dat

TEMPERATURE DATA FILE: C:\WHI\UNSAT22\data\P584.VHP_weather2.dat

SOLAR RADIATION DATA FILE: C:\WHI\UNSAT22\data\P584.VHP_weather3.dat

EVAPOTRANSPIRATION DATA: C:\WHI\UNSAT22\data\P584.VHP_weather4.dat

SOIL AND DESIGN DATA FILE: C:\WHI\UNSAT22\data\P584.VHP\I_386256.inp

OUTPUT DATA FILE: C:\WHI\UNSAT22\data\P584.VHP\O_386256.prt

TIME: 19:22   DATE: 6/18/2002

****

TITLE: Evap/Biobarrier (19) profile1

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NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
       COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 7

```
THICKNESS                  =      15.24    CM
POROSITY                   =       0.4730 VOL/VOL
FIELD CAPACITY             =       0.2220 VOL/VOL
WILTING POINT              =       0.1040 VOL/VOL
INITIAL SOIL WATER CONTENT =       0.2075 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000000000E-03 CM/SEC
```

NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 3.00
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 9

```
THICKNESS                  =     121.92    CM
POROSITY                   =       0.5000 VOL/VOL
FIELD CAPACITY             =       0.2840 VOL/VOL
WILTING POINT              =       0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT =       0.2057 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.120000000000E-04 CM/SEC
```

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

```
THICKNESS                  =      45.72    CM
POROSITY                   =       0.3970 VOL/VOL
FIELD CAPACITY             =       0.0320 VOL/VOL
WILTING POINT              =       0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT =       0.0322 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.300000000000E-02 CM/SEC
SLOPE                      =       0.00    PERCENT
DRAINAGE LENGTH            =  10000.0      METERS
```

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 10

```
THICKNESS                  =       3.05    CM
POROSITY                   =       0.4370 VOL/VOL
FIELD CAPACITY             =       0.1100 VOL/VOL
WILTING POINT              =       0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT =       0.4370 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.170000000000E-02 CM/SEC
```

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 4

```
THICKNESS                   =     30.48    CM
POROSITY                    =      0.4370 VOL/VOL
FIELD CAPACITY              =      0.1050 VOL/VOL
WILTING POINT               =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.1050 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.170000000000E-02 CM/SEC
```

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 4

```
THICKNESS                   =    457.20    CM
POROSITY                    =      0.4370 VOL/VOL
FIELD CAPACITY              =      0.1050 VOL/VOL
WILTING POINT               =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.1050 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.200000000000E-01 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 7 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 3.% AND A SLOPE LENGTH OF 11. METERS.

```
SCS RUNOFF CURVE NUMBER            =    77.92
FRACTION OF AREA ALLOWING RUNOFF   =   100.0     PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =     0.2428  HECTARES
EVAPORATIVE ZONE DEPTH             =    81.3     CM
INITIAL WATER IN EVAPORATIVE ZONE  =    12.372   CM
UPPER LIMIT OF EVAPORATIVE STORAGE =    40.229   CM
LOWER LIMIT OF EVAPORATIVE STORAGE =    10.831   CM
INITIAL SNOW WATER                 =     0.155   CM
INITIAL WATER IN LAYER MATERIALS   =    82.252   CM
TOTAL INITIAL WATER                =    82.407   CM
TOTAL SUBSURFACE INFLOW            =     0.00    MM/YR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM INEEL/NRF OU 8-08 SitesID

```
STATION LATITUDE                          =  43.63 DEGREES
MAXIMUM LEAF AREA INDEX                   =   2.00
START OF GROWING SEASON (JULIAN DATE)     =    132
END OF GROWING SEASON (JULIAN DATE)       =    275
EVAPORATIVE ZONE DEPTH                    =  48.0  INCHES
AVERAGE ANNUAL WIND SPEED                 =   7.20 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY     =  65.30 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY     =  42.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY     =  33.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY     =  58.60 %
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.70	0.63	0.62	0.72	1.24	1.22
0.50	0.53	0.65	0.50	0.65	0.70

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
16.10	21.70	30.50	41.60	51.20	60.00
68.00	66.00	55.50	44.00	29.90	18.70

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID AND STATION LATITUDE = 43.63 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.72	0.86	1.12	0.91	3.11	1.03
	1.41	1.01	1.65	0.27	0.24	0.20
RUNOFF	0.000	0.092	0.213	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.403	0.587	0.505	1.084	2.334	2.285
	3.260	1.062	0.701	0.517	0.216	0.200
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH	0.0013	0.0012	0.0013	0.0011	0.0012	0.0008
LAYER 4	0.0011	0.0012	0.0012	0.0012	0.0013	0.0013
PERCOLATION/LEAKAGE THROUGH	0.0011	0.0020	0.0007	0.0006	0.0016	0.0010
LAYER 6	0.0017	0.0007	0.0028	0.0011	0.0004	0.0011

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 100

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.53	29467.698	100.00
RUNOFF	0.306	665.647	2.26
EVAPOTRANSPIRATION	13.154	28648.364	97.22
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 4	0.014111	30.733	0.10
AVG. HEAD ON TOP OF LAYER 4	0.0000		
PERC./LEAKAGE THROUGH LAYER 6	0.014737	32.096	0.11
CHANGE IN WATER STORAGE	0.056	121.591	0.41
SOIL WATER AT START OF YEAR	32.502	70787.388	
SOIL WATER AT END OF YEAR	32.772	71376.342	
SNOW WATER AT START OF YEAR	0.215	467.363	1.59
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.000	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.75	0.69	0.62	0.69	1.17	1.23
	0.53	0.54	0.56	0.44	0.64	0.72
STD. DEVIATIONS	0.32	0.32	0.27	0.30	0.68	0.78
	0.40	0.43	0.50	0.32	0.31	0.31
RUNOFF						
TOTALS	0.000	0.013	0.042	0.002	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.029	0.102	0.006	0.000	0.004
	0.000	0.000	0.000	0.000	0.001	0.000
EVAPOTRANSPIRATION						
TOTALS	0.496	0.519	0.473	0.979	1.263	1.565
	1.076	0.510	0.421	0.364	0.353	0.505
STD. DEVIATIONS	0.100	0.109	0.159	0.297	0.490	0.604
	0.686	0.399	0.333	0.188	0.135	0.139
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0010	0.0009	0.0010	0.0009	0.0008	0.0007
	0.0008	0.0009	0.0009	0.0010	0.0010	0.0010
STD. DEVIATIONS	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003
	0.0003	0.0004	0.0004	0.0004	0.0004	0.0004
PERCOLATION/LEAKAGE THROUGH LAYER 6						
TOTALS	0.0010	0.0010	0.0010	0.0009	0.0008	0.0007
	0.0008	0.0009	0.0009	0.0008	0.0009	0.0010
STD. DEVIATIONS	0.0005	0.0005	0.0005	0.0006	0.0006	0.0006
	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.60 (1.649)	18721.2	100.00
RUNOFF	0.058 (0.1111)	125.34	0.669
EVAPOTRANSPIRATION	8.524 (1.5069)	18565.38	99.167
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.00000 (0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.01096 (0.00418)	23.863	0.12746
AVERAGE HEAD ON TOP OF LAYER 4	0.000 (0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.01073 (0.00413)	23.377	0.12487
CHANGE IN WATER STORAGE	0.003 (0.6102)	7.15	0.038

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100 and their dates (DDDYYYY

	(INCHES)	(CU. FT.)	
PRECIPITATION	1.94	4225.22791	1550045
RUNOFF	0.396	863.35229	810093
DRAINAGE COLLECTED FROM LAYER 3	0.00000	0.00000	0
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000058	0.12674	3110046
AVERAGE HEAD ON TOP OF LAYER 4	0.000		
MAXIMUM HEAD ON TOP OF LAYER 4	0.000		
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000446	0.97157	1420063

SNOW WATER	2.28	4974.6327	480036

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.2529

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1332

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(INCHES)	(VOL/VOL)
1	1.1745	0.1958
2	10.0751	0.2099
3	0.8160	0.0453
4	0.5244	0.4370
5	1.2832	0.1069
6	18.8990	0.1050
SNOW WATER	0.000	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE             **
**                HELP MODEL VERSION 3.07  (1 November 1997)              **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                  **
**                   USAE WATERWAYS EXPERIMENT STATION                    **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY            **
**                                                                        **
**                                                                        **
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```

PRECIPITATION DATA FILE: C:\WHI\UNSAT22\data\P632.VHP_weather1.dat

TEMPERATURE DATA FILE: C:\WHI\UNSAT22\data\P632.VHP_weather2.dat

SOLAR RADIATION DATA FILE: C:\WHI\UNSAT22\data\P632.VHP_weather3.dat

EVAPOTRANSPIRATION DATA: C:\WHI\UNSAT22\data\P632.VHP_weather4.dat

SOIL AND DESIGN DATA FILE: C:\WHI\UNSAT22\data\P632.VHP\I_386389.inp

OUTPUT DATA FILE: C:\WHI\UNSAT22\data\P632.VHP\O_386389.prt

TIME: 8:20   DATE: 6/19/2002

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     TITLE:  Evap/Biobarrier (14&12B) profile1

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NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
WERE SPECIFIED BY THE USER.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 7

```
THICKNESS                   =     15.24    CM
POROSITY                    =      0.4730 VOL/VOL
FIELD CAPACITY              =      0.2220 VOL/VOL
WILTING POINT               =      0.1040 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.1500 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000000000E-03 CM/SEC
NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
       FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 9

```
THICKNESS                   =    121.92    CM
POROSITY                    =      0.5000 VOL/VOL
FIELD CAPACITY              =      0.2840 VOL/VOL
WILTING POINT               =      0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2150 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.120000000000E-04 CM/SEC
```

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

```
THICKNESS                   =     45.72    CM
POROSITY                    =      0.3970 VOL/VOL
FIELD CAPACITY              =      0.0320 VOL/VOL
WILTING POINT               =      0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0270 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.300000000000E-02 CM/SEC
SLOPE                       =      0.00    PERCENT
DRAINAGE LENGTH             =  10000.0     METERS
```

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 10

```
THICKNESS                   =      3.05    CM
POROSITY                    =      0.4370 VOL/VOL
FIELD CAPACITY              =      0.1050 VOL/VOL
WILTING POINT               =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.4370 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.170000000000E-02 CM/SEC
```

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 4

THICKNESS	=	60.96 CM
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.1050 VOL/VOL
WILTING POINT	=	0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1000 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.170000000000E-02 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 4

THICKNESS	=	883.92 CM
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.1050 VOL/VOL
WILTING POINT	=	0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1000 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.200000000000E-01 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 7 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 3.% AND A SLOPE LENGTH OF 61. METERS.

SCS RUNOFF CURVE NUMBER	=	75.44	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.4164	HECTARES
EVAPORATIVE ZONE DEPTH	=	81.3	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	16.485	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	40.229	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	10.831	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	125.553	CM
TOTAL INITIAL WATER	=	125.553	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM INEEL/NRF OU 8-08 SitesID

```
STATION LATITUDE                          =  43.63 DEGREES
MAXIMUM LEAF AREA INDEX                   =   2.00
START OF GROWING SEASON (JULIAN DATE)     =    132
END OF GROWING SEASON (JULIAN DATE)       =    275
EVAPORATIVE ZONE DEPTH                    =  48.0  INCHES
AVERAGE ANNUAL WIND SPEED                 =   7.20 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY     =  65.30 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY     =  42.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY     =  33.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY     =  58.60 %
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.28	1.20	0.92	1.25	2.21	2.45
1.15	1.65	1.76	0.83	0.95	1.70

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
12.90	14.10	27.30	39.30	50.00	55.30
66.30	68.50	56.50	45.70	32.50	10.90

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID AND STATION LATITUDE = 43.63 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.17	1.42	0.53	1.50	3.48	5.23
	0.41	3.49	2.30	0.01	1.06	1.90
RUNOFF	0.000	0.000	0.577	0.318	0.001	0.006
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.472	0.483	0.471	0.744	2.265	3.805
	5.718	3.308	1.832	0.475	0.496	0.403
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH	0.0468	0.0398	0.0405	0.0357	0.0361	0.0282
LAYER 4	0.0339	0.0324	0.0245	0.0052	0.0000	0.0026
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0005

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.001	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.50	285856.269	100.00
RUNOFF	0.902	11462.363	4.01
EVAPOTRANSPIRATION	20.473	260108.271	90.99
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 4	0.325671	4137.565	1.45
AVG. HEAD ON TOP OF LAYER 4	0.0003		
PERC./LEAKAGE THROUGH LAYER 6	0.000503	6.390	0.00
CHANGE IN WATER STORAGE	1.124	14279.250	5.00
SOIL WATER AT START OF YEAR	52.630	668647.697	
SOIL WATER AT END OF YEAR	53.059	674103.848	
SNOW WATER AT START OF YEAR	0.802	10190.083	3.56
SNOW WATER AT END OF YEAR	1.497	19013.182	6.65
ANNUAL WATER BUDGET BALANCE	0.0000	-0.004	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.29	1.30	0.99	1.13	2.11	2.27
	1.20	2.31	1.84	0.81	0.81	1.41
STD. DEVIATIONS	0.65	0.29	0.38	0.67	1.46	1.48
	0.89	1.89	1.66	0.68	0.29	0.53
RUNOFF						
TOTALS	0.000	0.000	0.485	0.513	0.011	0.001
	0.000	0.009	0.015	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.412	0.633	0.034	0.002
	0.000	0.027	0.036	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.457	0.462	0.565	1.085	1.750	2.426
	4.358	2.466	0.980	0.537	0.421	0.421
STD. DEVIATIONS	0.092	0.074	0.125	0.353	0.674	0.686
	1.073	1.278	0.696	0.211	0.147	0.066
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0047	0.0040	0.0094	0.0107	0.0107	0.0092
	0.0095	0.0088	0.0074	0.0053	0.0036	0.0049
STD. DEVIATIONS	0.0148	0.0126	0.0200	0.0239	0.0241	0.0212
	0.0209	0.0193	0.0166	0.0149	0.0112	0.0145
PERCOLATION/LEAKAGE THROUGH LAYER 6						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0001	0.0000	0.0001	0.0001	0.0001	0.0001
	0.0001	0.0001	0.0001	0.0001	0.0000	0.0001
STD. DEVIATIONS	0.0002	0.0002	0.0002	0.0003	0.0003	0.0002
	0.0002	0.0002	0.0002	0.0002	0.0001	0.0002

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	17.47 (3.114)	222002.3	100.00
RUNOFF	1.033 (0.5413)	13121.84	5.911
EVAPOTRANSPIRATION	15.929 (1.9645)	202367.93	91.156
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.00000 (0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.08794 (0.19304)	1117.311	0.50329
AVERAGE HEAD ON TOP OF LAYER 4	0.000 (0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00006 (0.00016)	0.770	0.00035
CHANGE IN WATER STORAGE	0.513 (2.0771)	6511.80	2.933

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 10 and their dates (DDDYYYY

	(INCHES)	(CU. FT.)	
PRECIPITATION	2.64	33540.46894	2210009
RUNOFF	0.720	9142.26827	1070008
DRAINAGE COLLECTED FROM LAYER 3	0.00000	0.00000	910009
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.002378	30.21264	1090009
AVERAGE HEAD ON TOP OF LAYER 4	0.001		
MAXIMUM HEAD ON TOP OF LAYER 4	0.000		
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000169	2.14931	3490010

SNOW WATER	4.81	61066.1370	700004

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4054

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1332

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 10

LAYER	(INCHES)	(VOL/VOL)
1	1.4998	0.2500
2	11.7007	0.2438
3	1.2555	0.0697
4	0.5244	0.4370
5	3.2694	0.1362
6	34.8095	0.1000
SNOW WATER	1.497	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 November 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:     C:\WHI\UNSAT22\data\P632.VHP\_weather1.dat


TEMPERATURE DATA FILE:       C:\WHI\UNSAT22\data\P632.VHP\_weather2.dat


SOLAR RADIATION DATA FILE:   C:\WHI\UNSAT22\data\P632.VHP\_weather3.dat


EVAPOTRANSPIRATION DATA:     C:\WHI\UNSAT22\data\P632.VHP\_weather4.dat


SOIL AND DESIGN DATA FILE:   C:\WHI\UNSAT22\data\P632.VHP\I_386408.inp


OUTPUT DATA FILE:            C:\WHI\UNSAT22\data\P632.VHP\O_386408.prt



TIME:   8:20      DATE:   6/19/2002


******************************************************************************

     TITLE:  Evap/Biobarrier (21A) profile 1

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.
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```
                    LAYER  1
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   7
THICKNESS                   =     15.24    CM
POROSITY                    =       0.4730 VOL/VOL
FIELD CAPACITY              =       0.2220 VOL/VOL
WILTING POINT               =       0.1040 VOL/VOL
INITIAL SOIL WATER CONTENT  =       0.1500 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000000000E-03 CM/SEC
NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
       FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                    LAYER  2
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   9
THICKNESS                   =    121.92    CM
POROSITY                    =       0.5000 VOL/VOL
FIELD CAPACITY              =       0.2840 VOL/VOL
WILTING POINT               =       0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT  =       0.2150 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.120000000000E-04 CM/SEC


                    LAYER  3
                    --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  21
THICKNESS                   =     45.72    CM
POROSITY                    =       0.3970 VOL/VOL
FIELD CAPACITY              =       0.0320 VOL/VOL
WILTING POINT               =       0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT  =       0.0270 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.300000000000E-02 CM/SEC
SLOPE                       =       0.00   PERCENT
DRAINAGE LENGTH             =  10000.0     METERS


                    LAYER  4
                    --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  10
THICKNESS                   =       3.05   CM
POROSITY                    =       0.4370 VOL/VOL
FIELD CAPACITY              =       0.1100 VOL/VOL
WILTING POINT               =       0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT  =       0.4370 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.170000000000E-02 CM/SEC
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                         LAYER  5
                         --------

             TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER   4
 THICKNESS                    =      91.44   CM
 POROSITY                     =        0.4370 VOL/VOL
 FIELD CAPACITY               =        0.1050 VOL/VOL
 WILTING POINT                =        0.0470 VOL/VOL
 INITIAL SOIL WATER CONTENT   =        0.1000 VOL/VOL
 EFFECTIVE SAT. HYD. COND.    =   0.170000000000E-02 CM/SEC


                         LAYER  6
                         --------

             TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER   4
 THICKNESS                    =     426.72   CM
 POROSITY                     =        0.4370 VOL/VOL
 FIELD CAPACITY               =        0.1050 VOL/VOL
 WILTING POINT                =        0.0470 VOL/VOL
 INITIAL SOIL WATER CONTENT   =        0.1000 VOL/VOL
 EFFECTIVE SAT. HYD. COND.    =   0.200000000000E-01 CM/SEC


           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
          SOIL DATA BASE USING SOIL TEXTURE # 7 WITH A
          FAIR STAND OF GRASS, A SURFACE SLOPE OF  3.%
          AND A SLOPE LENGTH OF   21. METERS.

 SCS RUNOFF CURVE NUMBER            =      76.97
 FRACTION OF AREA ALLOWING RUNOFF   =     100.0     PERCENT
 AREA PROJECTED ON HORIZONTAL PLANE =       0.6070 HECTARES
 EVAPORATIVE ZONE DEPTH             =      81.3     CM
 INITIAL WATER IN EVAPORATIVE ZONE  =      16.485   CM
 UPPER LIMIT OF EVAPORATIVE STORAGE =      40.229   CM
 LOWER LIMIT OF EVAPORATIVE STORAGE =      10.831   CM
 INITIAL SNOW WATER                 =       0.000   CM
 INITIAL WATER IN LAYER MATERIALS   =      82.881   CM
 TOTAL INITIAL WATER                =      82.881   CM
 TOTAL SUBSURFACE INFLOW            =       0.00    MM/YR


            EVAPOTRANSPIRATION AND WEATHER DATA
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 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          INEEL/NRF OU 8-08 SitesID
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STATION LATITUDE	=	43.63 DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	132
END OF GROWING SEASON (JULIAN DATE)	=	275
EVAPORATIVE ZONE DEPTH	=	48.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.20 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	65.30 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	42.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	33.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	58.60 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.28	1.20	0.92	1.25	2.21	2.45
1.15	1.65	1.76	0.83	0.95	1.70

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
12.90	14.10	27.30	39.30	50.00	55.30
66.30	68.50	56.50	45.70	32.50	10.90

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID AND STATION LATITUDE = 43.63 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.17	1.42	0.53	1.50	3.48	5.23
	0.41	3.49	2.30	0.01	1.06	1.90
RUNOFF	0.000	0.000	0.577	0.318	0.006	0.016
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.472	0.483	0.471	0.743	2.263	3.805
	5.718	3.308	1.836	0.477	0.496	0.403
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH	0.0462	0.0401	0.0411	0.0363	0.0380	0.0287
LAYER 4	0.0268	0.0358	0.0270	0.0065	0.0000	0.0031
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
LAYER 6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.001	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.50	122509.830	100.00
RUNOFF	0.917	4994.751	4.08
EVAPOTRANSPIRATION	20.477	111496.820	91.01
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 4	0.329676	1795.047	1.47
AVG. HEAD ON TOP OF LAYER 4	0.0003		
PERC./LEAKAGE THROUGH LAYER 6	0.000103	0.563	0.00
CHANGE IN WATER STORAGE	1.105	6017.697	4.91
SOIL WATER AT START OF YEAR	35.708	194426.735	
SOIL WATER AT END OF YEAR	36.119	196663.104	
SNOW WATER AT START OF YEAR	0.802	4367.179	3.56
SNOW WATER AT END OF YEAR	1.497	8148.507	6.65
ANNUAL WATER BUDGET BALANCE	0.0000	-0.002	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.29	1.30	0.99	1.13	2.11	2.27
	1.20	2.31	1.84	0.81	0.81	1.41
STD. DEVIATIONS	0.65	0.29	0.38	0.67	1.46	1.48
	0.89	1.89	1.66	0.68	0.29	0.53
RUNOFF						
TOTALS	0.000	0.000	0.484	0.513	0.015	0.002
	0.000	0.014	0.020	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.411	0.633	0.044	0.005
	0.000	0.039	0.048	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.457	0.462	0.565	1.085	1.747	2.429
	4.386	2.440	0.977	0.537	0.421	0.421
STD. DEVIATIONS	0.092	0.074	0.125	0.353	0.670	0.699
	1.084	1.277	0.697	0.211	0.148	0.066
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0046	0.0040	0.0041	0.0056	0.0096	0.0087
	0.0085	0.0090	0.0075	0.0053	0.0036	0.0046
STD. DEVIATIONS	0.0146	0.0127	0.0130	0.0125	0.0208	0.0197
	0.0195	0.0196	0.0167	0.0147	0.0114	0.0135
PERCOLATION/LEAKAGE THROUGH LAYER 6						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0001	0.0000	0.0000	0.0001	0.0001	0.0001
	0.0001	0.0001	0.0001	0.0001	0.0000	0.0001
STD. DEVIATIONS	0.0002	0.0002	0.0001	0.0001	0.0002	0.0002
	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 10

	INCHES		CU. FEET	PERCENT
PRECIPITATION	17.47	(3.114)	95143.9	100.00
RUNOFF	1.048	(0.5465)	5707.75	5.999
EVAPOTRANSPIRATION	15.927	(1.9632)	86721.73	91.148
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.00000	(0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.07533	(0.16035)	410.181	0.43112
AVERAGE HEAD ON TOP OF LAYER 4	0.000	(0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00001	(0.00003)	0.056	0.00006
CHANGE IN WATER STORAGE	0.499	(2.0705)	2714.32	2.853

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 10 and their dates (DDDYYYY

	(INCHES)	(CU. FT.)	
PRECIPITATION	2.64	14374.48669	2210009
RUNOFF	0.719	3914.94314	1070008
DRAINAGE COLLECTED FROM LAYER 3	0.00000	0.00000	1520009
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.001968	10.71726	1710009
AVERAGE HEAD ON TOP OF LAYER 4	0.001		
MAXIMUM HEAD ON TOP OF LAYER 4	0.000		
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000103	0.56345	340010

SNOW WATER	4.81	26171.2016	700004

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4041

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1332

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 10

LAYER	(INCHES)	(VOL/VOL)
1	1.4998	0.2500
2	11.6879	0.2435
3	1.2535	0.0696
4	0.5244	0.4370
5	4.3533	0.1209
6	16.7999	0.1000
SNOW WATER	1.497	

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**                                                                          **
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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 November 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:     C:\WHI\UNSAT22\data\P632.VHP\_weather1.dat
TEMPERATURE DATA FILE:       C:\WHI\UNSAT22\data\P632.VHP\_weather2.dat
SOLAR RADIATION DATA FILE:   C:\WHI\UNSAT22\data\P632.VHP\_weather3.dat
EVAPOTRANSPIRATION DATA:     C:\WHI\UNSAT22\data\P632.VHP\_weather4.dat
SOIL AND DESIGN DATA FILE:   C:\WHI\UNSAT22\data\P632.VHP\I_386427.inp
OUTPUT DATA FILE:            C:\WHI\UNSAT22\data\P632.VHP\O_386427.prt


TIME:   8:20      DATE:   6/19/2002


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     TITLE:  Evap/Biobarrier (19) profile1

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.
```

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 7

```
THICKNESS                  =      15.24   CM
POROSITY                   =       0.4730 VOL/VOL
FIELD CAPACITY             =       0.2220 VOL/VOL
WILTING POINT              =       0.1040 VOL/VOL
INITIAL SOIL WATER CONTENT =       0.1500 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000000000E-03 CM/SEC
NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
      FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 9

```
THICKNESS                  =     121.92   CM
POROSITY                   =       0.5000 VOL/VOL
FIELD CAPACITY             =       0.2840 VOL/VOL
WILTING POINT              =       0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT =       0.2150 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.120000000000E-04 CM/SEC
```

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

```
THICKNESS                  =      45.72   CM
POROSITY                   =       0.3970 VOL/VOL
FIELD CAPACITY             =       0.0320 VOL/VOL
WILTING POINT              =       0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT =       0.0270 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.300000000000E-02 CM/SEC
SLOPE                      =       0.00   PERCENT
DRAINAGE LENGTH            =  10000.0     METERS
```

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 10

```
THICKNESS                  =       3.05   CM
POROSITY                   =       0.4370 VOL/VOL
FIELD CAPACITY             =       0.1100 VOL/VOL
WILTING POINT              =       0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT =       0.4370 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.170000000000E-02 CM/SEC
```

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 4

THICKNESS	=	30.48 CM
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.1050 VOL/VOL
WILTING POINT	=	0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1000 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.170000000000E-02 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 4

THICKNESS	=	457.20 CM
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.1050 VOL/VOL
WILTING POINT	=	0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1000 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.200000000000E-01 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 7 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 3.% AND A SLOPE LENGTH OF 11. METERS.

SCS RUNOFF CURVE NUMBER	=	77.92	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	0.2428	HECTARES
EVAPORATIVE ZONE DEPTH	=	81.3	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	16.485	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	40.229	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	10.831	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	79.833	CM
TOTAL INITIAL WATER	=	79.833	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM INEEL/NRF OU 8-08 SitesID

STATION LATITUDE	=	43.63 DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	132
END OF GROWING SEASON (JULIAN DATE)	=	275
EVAPORATIVE ZONE DEPTH	=	48.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.20 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	65.30 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	42.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	33.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	58.60 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.28	1.20	0.92	1.25	2.21	2.45
1.15	1.65	1.76	0.83	0.95	1.70

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
12.90	14.10	27.30	39.30	50.00	55.30
66.30	68.50	56.50	45.70	32.50	10.90

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID
AND STATION LATITUDE = 43.63 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.17	1.42	0.53	1.50	3.48	5.23
	0.41	3.49	2.30	0.01	1.06	1.90
RUNOFF	0.000	0.000	0.577	0.318	0.010	0.027
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.472	0.483	0.471	0.743	2.266	3.798
	5.718	3.310	1.834	0.477	0.496	0.403
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH	0.0462	0.0393	0.0400	0.0353	0.0333	0.0345
LAYER 4	0.0334	0.0300	0.0230	0.0059	0.0000	0.0004
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0016	0.0001	0.0000	0.0000	0.0021
LAYER 6	0.0022	0.0085	0.0003	0.0014	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.001	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.50	49003.932	100.00
RUNOFF	0.932	2029.428	4.14
EVAPOTRANSPIRATION	20.473	44590.122	90.99
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 4	0.321352	699.889	1.43
AVG. HEAD ON TOP OF LAYER 4	0.0003		
PERC./LEAKAGE THROUGH LAYER 6	0.016215	35.317	0.07
CHANGE IN WATER STORAGE	1.079	2349.066	4.79
SOIL WATER AT START OF YEAR	34.480	75095.640	
SOIL WATER AT END OF YEAR	34.864	75932.174	
SNOW WATER AT START OF YEAR	0.802	1746.871	3.56
SNOW WATER AT END OF YEAR	1.497	3259.403	6.65
ANNUAL WATER BUDGET BALANCE	0.0000	-0.001	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.29	1.30	0.99	1.13	2.11	2.27
	1.20	2.31	1.84	0.81	0.81	1.41
STD. DEVIATIONS	0.65	0.29	0.38	0.67	1.46	1.48
	0.89	1.89	1.66	0.68	0.29	0.53
RUNOFF						
TOTALS	0.000	0.000	0.484	0.512	0.017	0.004
	0.000	0.018	0.024	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.411	0.633	0.051	0.009
	0.000	0.048	0.057	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.457	0.462	0.565	1.085	1.746	2.435
	4.380	2.436	0.975	0.537	0.421	0.421
STD. DEVIATIONS	0.092	0.074	0.125	0.353	0.668	0.686
	1.080	1.279	0.697	0.210	0.148	0.066
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0046	0.0039	0.0040	0.0044	0.0088	0.0092
	0.0091	0.0084	0.0072	0.0053	0.0036	0.0046
STD. DEVIATIONS	0.0146	0.0124	0.0126	0.0112	0.0192	0.0200
	0.0200	0.0186	0.0163	0.0148	0.0115	0.0144
PERCOLATION/LEAKAGE THROUGH LAYER 6						
TOTALS	0.0000	0.0002	0.0000	0.0000	0.0000	0.0002
	0.0002	0.0008	0.0000	0.0001	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0005	0.0000	0.0000	0.0000	0.0007
	0.0007	0.0027	0.0001	0.0004	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0001	0.0000	0.0000	0.0001	0.0001	0.0001
	0.0001	0.0001	0.0001	0.0001	0.0000	0.0001
STD. DEVIATIONS	0.0002	0.0002	0.0001	0.0001	0.0002	0.0002
	0.0002	0.0002	0.0002	0.0002	0.0001	0.0002

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 10

	INCHES		CU. FEET	PERCENT
PRECIPITATION	17.47	(3.114)	38057.5	100.00
RUNOFF	1.060	(0.5504)	2309.23	6.068
EVAPOTRANSPIRATION	15.919	(1.9633)	34671.01	91.102
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.00000	(0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.07315	(0.15563)	159.315	0.41862
AVERAGE HEAD ON TOP OF LAYER 4	0.000	(0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00162	(0.00513)	3.532	0.00928
CHANGE IN WATER STORAGE	0.493	(2.0614)	1073.78	2.821

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 10 and their dates (DDDYYYY

	(INCHES)	(CU. FT.)	
PRECIPITATION	2.64	5749.79468	2210009
RUNOFF	0.719	1565.16654	1070008
DRAINAGE COLLECTED FROM LAYER 3	0.00000	0.00000	1600009
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.001907	4.15382	1670009
AVERAGE HEAD ON TOP OF LAYER 4	0.001		
MAXIMUM HEAD ON TOP OF LAYER 4	0.000		
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000400	0.87211	1760010

SNOW WATER	4.81	10468.4806	700004

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4031

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1332

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 10

LAYER	(INCHES)	(VOL/VOL)
1	1.4998	0.2500
2	11.6874	0.2435
3	1.2371	0.0687
4	0.5244	0.4370
5	1.6034	0.1336
6	18.3118	0.1017
SNOW WATER	1.497	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**               HELP MODEL VERSION 3.07  (1 November 1997)                 **
**                DEVELOPED BY ENVIRONMENTAL LABORATORY                     **
**                  USAE WATERWAYS EXPERIMENT STATION                       **
**          FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                 **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:     C:\WHI\UNSAT22\data\P616.VHP\_weather1.dat

TEMPERATURE DATA FILE:       C:\WHI\UNSAT22\data\P616.VHP\_weather2.dat

SOLAR RADIATION DATA FILE:   C:\WHI\UNSAT22\data\P616.VHP\_weather3.dat

EVAPOTRANSPIRATION DATA:     C:\WHI\UNSAT22\data\P616.VHP\_weather4.dat

SOIL AND DESIGN DATA FILE:   C:\WHI\UNSAT22\data\P616.VHP\I_386332.inp

OUTPUT DATA FILE:            C:\WHI\UNSAT22\data\P616.VHP\O_386332.prt


TIME:   7:55      DATE:   6/19/2002


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     TITLE:  Evap/Biobarrier (14&12B) profile1

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.
```

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 7

```
THICKNESS                  =      15.24    CM
POROSITY                   =        0.4730 VOL/VOL
FIELD CAPACITY             =        0.2220 VOL/VOL
WILTING POINT              =        0.1040 VOL/VOL
INITIAL SOIL WATER CONTENT =        0.2246 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =   0.100000000000E-03 CM/SEC
NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 3.00
      FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 9

```
THICKNESS                  =     121.92    CM
POROSITY                   =        0.5000 VOL/VOL
FIELD CAPACITY             =        0.2840 VOL/VOL
WILTING POINT              =        0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT =        0.2103 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =   0.120000000000E-04 CM/SEC
```

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

```
THICKNESS                  =      45.72    CM
POROSITY                   =        0.3970 VOL/VOL
FIELD CAPACITY             =        0.0320 VOL/VOL
WILTING POINT              =        0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT =        0.0323 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =   0.300000000000E-02 CM/SEC
SLOPE                      =       0.00    PERCENT
DRAINAGE LENGTH            =   10000.0     METERS
```

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 10

```
THICKNESS                  =       3.05    CM
POROSITY                   =        0.4370 VOL/VOL
FIELD CAPACITY             =        0.1100 VOL/VOL
WILTING POINT              =        0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT =        0.4370 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =   0.170000000000E-02 CM/SEC
```

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 4

```
THICKNESS                   =     60.96    CM
POROSITY                    =      0.4370 VOL/VOL
FIELD CAPACITY              =      0.1050 VOL/VOL
WILTING POINT               =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.1050 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.170000000000E-02 CM/SEC
```

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 4

```
THICKNESS                   =    883.92    CM
POROSITY                    =      0.4370 VOL/VOL
FIELD CAPACITY              =      0.1050 VOL/VOL
WILTING POINT               =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.1050 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.200000000000E-01 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 7 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 3.% AND A SLOPE LENGTH OF 61. METERS.

```
SCS RUNOFF CURVE NUMBER              =     75.44
FRACTION OF AREA ALLOWING RUNOFF     =    100.0     PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =      1.4164  HECTARES
EVAPORATIVE ZONE DEPTH               =     81.3     CM
INITIAL WATER IN EVAPORATIVE ZONE    =     13.187   CM
UPPER LIMIT OF EVAPORATIVE STORAGE   =     40.229   CM
LOWER LIMIT OF EVAPORATIVE STORAGE   =     10.831   CM
INITIAL SNOW WATER                   =      4.427   CM
INITIAL WATER IN LAYER MATERIALS     =    131.079   CM
TOTAL INITIAL WATER                  =    135.507   CM
TOTAL SUBSURFACE INFLOW              =      0.00    MM/YR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM INEEL/NRF OU 8-08 SitesID

STATION LATITUDE	=	43.63 DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	132
END OF GROWING SEASON (JULIAN DATE)	=	275
EVAPORATIVE ZONE DEPTH	=	48.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.20 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	65.30 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	42.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	33.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	58.60 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.28	1.20	0.92	1.25	2.21	2.45
1.15	1.65	1.76	0.83	0.95	1.70

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
12.90	14.10	27.30	39.30	50.00	55.30
66.30	68.50	56.50	45.70	32.50	10.90

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID AND STATION LATITUDE = 43.63 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.17	1.42	0.53	1.50	3.48	5.23
	0.41	3.49	2.30	0.01	1.06	1.90
RUNOFF	0.000	0.000	0.577	0.318	0.001	0.006
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.472	0.483	0.471	0.743	2.266	3.799
	5.718	3.308	1.834	0.476	0.496	0.403
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH	0.0465	0.0394	0.0400	0.0353	0.0333	0.0349
LAYER 4	0.0332	0.0298	0.0230	0.0038	0.0000	0.0020
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 6	0.0000	0.0000	0.0000	0.0009	0.0182	0.0025

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.001	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.50	285856.269	100.00
RUNOFF	0.902	11463.114	4.01
EVAPOTRANSPIRATION	20.471	260073.635	90.98
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 4	0.321348	4082.634	1.43
AVG. HEAD ON TOP OF LAYER 4	0.0003		
PERC./LEAKAGE THROUGH LAYER 6	0.021558	273.887	0.10
CHANGE IN WATER STORAGE	1.106	14045.638	4.91
SOIL WATER AT START OF YEAR	56.219	714250.817	
SOIL WATER AT END OF YEAR	56.630	719473.357	
SNOW WATER AT START OF YEAR	0.802	10190.083	3.56
SNOW WATER AT END OF YEAR	1.497	19013.182	6.65
ANNUAL WATER BUDGET BALANCE	0.0000	-0.004	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.29	1.30	0.99	1.13	2.11	2.27
	1.20	2.31	1.84	0.81	0.81	1.41
STD. DEVIATIONS	0.65	0.29	0.38	0.67	1.46	1.48
	0.89	1.89	1.66	0.68	0.29	0.53
RUNOFF						
TOTALS	0.000	0.000	0.523	0.516	0.011	0.001
	0.000	0.009	0.015	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.399	0.638	0.034	0.002
	0.000	0.027	0.037	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.478	0.460	0.582	1.059	1.737	2.384
	4.418	2.477	0.980	0.529	0.392	0.419
STD. DEVIATIONS	0.080	0.071	0.125	0.345	0.636	0.664
	1.061	1.282	0.667	0.204	0.130	0.068
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0205	0.0169	0.0172	0.0157	0.0154	0.0130
	0.0125	0.0150	0.0508	0.0372	0.0265	0.0236
STD. DEVIATIONS	0.0422	0.0321	0.0307	0.0262	0.0245	0.0214
	0.0203	0.0198	0.1272	0.0939	0.0646	0.0518
PERCOLATION/LEAKAGE THROUGH LAYER 6						
TOTALS	0.0002	0.0003	0.0003	0.0002	0.0002	0.0002
	0.0001	0.0003	0.0007	0.0004	0.0019	0.0006
STD. DEVIATIONS	0.0007	0.0007	0.0006	0.0006	0.0005	0.0007
	0.0003	0.0007	0.0022	0.0009	0.0057	0.0011

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001
	0.0001	0.0002	0.0006	0.0004	0.0003	0.0003
STD. DEVIATIONS	0.0005	0.0004	0.0003	0.0003	0.0003	0.0002
	0.0002	0.0002	0.0014	0.0010	0.0007	0.0006

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 10

	INCHES		CU. FEET	PERCENT
PRECIPITATION	17.47	(3.114)	222002.3	100.00
RUNOFF	1.075	(0.4887)	13662.53	6.154
EVAPOTRANSPIRATION	15.915	(1.9730)	202200.27	91.080
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.00000	(0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.26440	(0.40803)	3359.096	1.51309
AVERAGE HEAD ON TOP OF LAYER 4	0.000	(0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00547	(0.00960)	69.451	0.03128
CHANGE IN WATER STORAGE	0.478	(2.0963)	6070.09	2.734

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 10 and their dates (DDDYYYY

	(INCHES)	(CU. FT.)	
PRECIPITATION	2.64	33540.46894	2210009
RUNOFF	0.732	9294.93865	840002
DRAINAGE COLLECTED FROM LAYER 3	0.00000	0.00000	2540008
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.014990	190.44495	2570008
AVERAGE HEAD ON TOP OF LAYER 4	0.005		
MAXIMUM HEAD ON TOP OF LAYER 4	0.000		
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000709	9.00203	3040010

SNOW WATER	4.81	61066.1370	700004

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4055
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1332

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 10

LAYER	(INCHES)	(VOL/VOL)
1	1.4998	0.2500
2	11.7017	0.2438
3	1.2553	0.0697
4	0.5244	0.4370
5	3.3593	0.1400
6	38.2900	0.1100
SNOW WATER	1.497	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07 (1 November 1997)                 **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:    C:\WHI\UNSAT22\data\P616.VHP\_weather1.dat

TEMPERATURE DATA FILE:      C:\WHI\UNSAT22\data\P616.VHP\_weather2.dat

SOLAR RADIATION DATA FILE:  C:\WHI\UNSAT22\data\P616.VHP\_weather3.dat

EVAPOTRANSPIRATION DATA:    C:\WHI\UNSAT22\data\P616.VHP\_weather4.dat

SOIL AND DESIGN DATA FILE:  C:\WHI\UNSAT22\data\P616.VHP\I_386351.inp

OUTPUT DATA FILE:           C:\WHI\UNSAT22\data\P616.VHP\O_386351.prt


TIME:  7:55     DATE:  6/19/2002


******************************************************************************

     TITLE:  Evap/Biobarrier (21A) profile 1

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.
```

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 7

```
THICKNESS                    =      15.24    CM
POROSITY                     =       0.4730 VOL/VOL
FIELD CAPACITY               =       0.2220 VOL/VOL
WILTING POINT                =       0.1040 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.2246 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.100000000000E-03 CM/SEC
NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
       FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 9

```
THICKNESS                    =     121.92    CM
POROSITY                     =       0.5000 VOL/VOL
FIELD CAPACITY               =       0.2840 VOL/VOL
WILTING POINT                =       0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.2103 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.120000000000E-04 CM/SEC
```

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

```
THICKNESS                    =      45.72    CM
POROSITY                     =       0.3970 VOL/VOL
FIELD CAPACITY               =       0.0320 VOL/VOL
WILTING POINT                =       0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.0323 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.300000000000E-02 CM/SEC
SLOPE                        =       0.00    PERCENT
DRAINAGE LENGTH              =  10000.0      METERS
```

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 10

```
THICKNESS                    =       3.05    CM
POROSITY                     =       0.4370 VOL/VOL
FIELD CAPACITY               =       0.1100 VOL/VOL
WILTING POINT                =       0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT   =       0.4370 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.170000000000E-02 CM/SEC
```

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 8

THICKNESS	=	91.44 CM
POROSITY	=	0.4630 VOL/VOL
FIELD CAPACITY	=	0.2320 VOL/VOL
WILTING POINT	=	0.1160 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2320 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000000000E-03 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 4

THICKNESS	=	426.72 CM
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.1050 VOL/VOL
WILTING POINT	=	0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1050 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.200000000000E-01 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 7 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 3.% AND A SLOPE LENGTH OF 21. METERS.

SCS RUNOFF CURVE NUMBER	=	76.97	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	0.6070	HECTARES
EVAPORATIVE ZONE DEPTH	=	81.3	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	13.187	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	40.229	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	10.831	CM
INITIAL SNOW WATER	=	4.427	CM
INITIAL WATER IN LAYER MATERIALS	=	97.887	CM
TOTAL INITIAL WATER	=	102.314	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM INEEL/NRF OU 8-08 SitesID

STATION LATITUDE	=	43.63 DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	132
END OF GROWING SEASON (JULIAN DATE)	=	275
EVAPORATIVE ZONE DEPTH	=	48.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.20 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	65.30 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	42.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	33.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	58.60 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.28	1.20	0.92	1.25	2.21	2.45
1.15	1.65	1.76	0.83	0.95	1.70

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
12.90	14.10	27.30	39.30	50.00	55.30
66.30	68.50	56.50	45.70	32.50	10.90

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID
AND STATION LATITUDE = 43.63 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.17	1.42	0.53	1.50	3.48	5.23
	0.41	3.49	2.30	0.01	1.06	1.90
RUNOFF	0.000	0.000	0.577	0.318	0.006	0.017
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.472	0.483	0.471	0.744	2.266	3.799
	5.718	3.308	1.838	0.477	0.496	0.403
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 4	0.0467	0.0395	0.0402	0.0354	0.0334	0.0348
	0.0337	0.0298	0.0230	0.0043	0.0000	0.0013
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0113	0.0000	0.0167	0.0107	0.0101	0.0009

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 4	0.001	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.50	122509.830	100.00
RUNOFF	0.917	4995.376	4.08
EVAPOTRANSPIRATION	20.476	111491.702	91.01
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 4	0.322079	1753.683	1.43
AVG. HEAD ON TOP OF LAYER 4	0.0003		
PERC./LEAKAGE THROUGH LAYER 6	0.049745	270.856	0.22
CHANGE IN WATER STORAGE	1.056	5751.897	4.70
SOIL WATER AT START OF YEAR	42.787	232967.763	
SOIL WATER AT END OF YEAR	43.148	234938.332	
SNOW WATER AT START OF YEAR	0.802	4367.179	3.56
SNOW WATER AT END OF YEAR	1.497	8148.507	6.65
ANNUAL WATER BUDGET BALANCE	0.0000	-0.002	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.29	1.30	0.99	1.13	2.11	2.27
	1.20	2.31	1.84	0.81	0.81	1.41
STD. DEVIATIONS	0.65	0.29	0.38	0.67	1.46	1.48
	0.89	1.89	1.66	0.68	0.29	0.53
RUNOFF						
TOTALS	0.000	0.000	0.523	0.516	0.015	0.002
	0.000	0.014	0.020	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.399	0.637	0.044	0.005
	0.000	0.039	0.049	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.478	0.460	0.582	1.059	1.738	2.385
	4.415	2.472	0.977	0.530	0.392	0.419
STD. DEVIATIONS	0.080	0.071	0.125	0.345	0.637	0.663
	1.059	1.279	0.670	0.204	0.130	0.068
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0207	0.0170	0.0173	0.0158	0.0154	0.0139
	0.0126	0.0126	0.0479	0.0369	0.0264	0.0238
STD. DEVIATIONS	0.0422	0.0321	0.0307	0.0261	0.0244	0.0216
	0.0203	0.0180	0.1197	0.0944	0.0650	0.0520
PERCOLATION/LEAKAGE THROUGH LAYER 6						
TOTALS	0.0032	0.0032	0.0034	0.0039	0.0044	0.0028
	0.0038	0.0033	0.0037	0.0030	0.0029	0.0032
STD. DEVIATIONS	0.0050	0.0045	0.0048	0.0061	0.0067	0.0052
	0.0051	0.0055	0.0057	0.0052	0.0041	0.0052

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
	0.0001	0.0001	0.0005	0.0004	0.0003	0.0003
STD. DEVIATIONS	0.0005	0.0004	0.0003	0.0003	0.0003	0.0002
	0.0002	0.0002	0.0014	0.0010	0.0007	0.0006

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	17.47 (3.114)	95143.9	100.00
RUNOFF	1.091 (0.4932)	5938.47	6.242
EVAPOTRANSPIRATION	15.906 (1.9758)	86606.38	91.027
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.00000 (0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.26041 (0.39544)	1417.926	1.49030
AVERAGE HEAD ON TOP OF LAYER 4	0.000 (0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.04094 (0.05033)	222.912	0.23429
CHANGE IN WATER STORAGE	0.436 (2.0573)	2376.10	2.497

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 10 and their dates (DDDYYYY

	(INCHES)	(CU. FT.)	
PRECIPITATION	2.64	14374.48669	2210009
RUNOFF	0.732	3983.54514	840002
DRAINAGE COLLECTED FROM LAYER 3	0.00000	0.00000	2560008
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.014323	77.98740	2570008
AVERAGE HEAD ON TOP OF LAYER 4	0.005		
MAXIMUM HEAD ON TOP OF LAYER 4	0.000		
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000779	4.24019	860006

SNOW WATER	4.81	26171.2016	700004

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4041

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1332

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 10

LAYER	(INCHES)	(VOL/VOL)
1	1.4998	0.2500
2	11.6905	0.2436
3	1.2471	0.0693
4	0.5244	0.4370
5	8.8179	0.2449
6	19.3688	0.1153
SNOW WATER	1.497	

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 November 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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******************************************************************************


PRECIPITATION DATA FILE:     C:\WHI\UNSAT22\data\P616.VHP\_weather1.dat

TEMPERATURE DATA FILE:       C:\WHI\UNSAT22\data\P616.VHP\_weather2.dat

SOLAR RADIATION DATA FILE:   C:\WHI\UNSAT22\data\P616.VHP\_weather3.dat

EVAPOTRANSPIRATION DATA:     C:\WHI\UNSAT22\data\P616.VHP\_weather4.dat

SOIL AND DESIGN DATA FILE:   C:\WHI\UNSAT22\data\P616.VHP\I_386370.inp

OUTPUT DATA FILE:            C:\WHI\UNSAT22\data\P616.VHP\O_386370.prt


TIME:   7:55      DATE:   6/19/2002


******************************************************************************

     TITLE:  Evap/Biobarrier (19) profile1

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.
```

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 7

```
THICKNESS                  =    15.24    CM
POROSITY                   =     0.4730 VOL/VOL
FIELD CAPACITY             =     0.2220 VOL/VOL
WILTING POINT              =     0.1040 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.2246 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.100000000000E-03 CM/SEC
NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
       FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 9

```
THICKNESS                  =   121.92    CM
POROSITY                   =     0.5000 VOL/VOL
FIELD CAPACITY             =     0.2840 VOL/VOL
WILTING POINT              =     0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.2103 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.120000000000E-04 CM/SEC
```

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

```
THICKNESS                  =    45.72    CM
POROSITY                   =     0.3970 VOL/VOL
FIELD CAPACITY             =     0.0320 VOL/VOL
WILTING POINT              =     0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.0323 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.300000000000E-02 CM/SEC
SLOPE                      =     0.00    PERCENT
DRAINAGE LENGTH            = 10000.0     METERS
```

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 10

```
THICKNESS                  =     3.05    CM
POROSITY                   =     0.4370 VOL/VOL
FIELD CAPACITY             =     0.1100 VOL/VOL
WILTING POINT              =     0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.4370 VOL/VOL
EFFECTIVE SAT. HYD. COND.  = 0.170000000000E-02 CM/SEC
```

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 4

```
THICKNESS                    =     30.48    CM
POROSITY                     =      0.4370 VOL/VOL
FIELD CAPACITY               =      0.1050 VOL/VOL
WILTING POINT                =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.1050 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.170000000000E-02 CM/SEC
```

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 4

```
THICKNESS                    =    457.20    CM
POROSITY                     =      0.4370 VOL/VOL
FIELD CAPACITY               =      0.1050 VOL/VOL
WILTING POINT                =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.1050 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.200000000000E-01 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
SOIL DATA BASE USING SOIL TEXTURE # 7 WITH A
FAIR STAND OF GRASS, A SURFACE SLOPE OF 3.%
AND A SLOPE LENGTH OF 11. METERS.

```
SCS RUNOFF CURVE NUMBER            =    77.92
FRACTION OF AREA ALLOWING RUNOFF   =   100.0     PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =     0.2428  HECTARES
EVAPORATIVE ZONE DEPTH             =    81.3     CM
INITIAL WATER IN EVAPORATIVE ZONE  =    13.187   CM
UPPER LIMIT OF EVAPORATIVE STORAGE =    40.229   CM
LOWER LIMIT OF EVAPORATIVE STORAGE =    10.831   CM
INITIAL SNOW WATER                 =     4.427   CM
INITIAL WATER IN LAYER MATERIALS   =    83.073   CM
TOTAL INITIAL WATER                =    87.501   CM
TOTAL SUBSURFACE INFLOW            =     0.00    MM/YR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
INEEL/NRF OU 8-08 SitesID

STATION LATITUDE	=	43.63 DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	132
END OF GROWING SEASON (JULIAN DATE)	=	275
EVAPORATIVE ZONE DEPTH	=	48.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.20 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	65.30 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	42.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	33.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	58.60 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.28	1.20	0.92	1.25	2.21	2.45
1.15	1.65	1.76	0.83	0.95	1.70

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
12.90	14.10	27.30	39.30	50.00	55.30
66.30	68.50	56.50	45.70	32.50	10.90

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR INEEL/NRF OU 8-08 SitesID AND STATION LATITUDE = 43.63 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.17	1.42	0.53	1.50	3.48	5.23
	0.41	3.49	2.30	0.01	1.06	1.90
RUNOFF	0.000	0.000	0.577	0.318	0.010	0.027
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.472	0.483	0.471	0.743	2.266	3.798
	5.718	3.309	1.836	0.477	0.496	0.403
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 4	0.0466	0.0392	0.0397	0.0350	0.0330	0.0326
	0.0316	0.0313	0.0240	0.0061	0.0000	0.0006
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.0161	0.0099	0.0094	0.0084	0.0076	0.0051
	0.0077	0.0053	0.0065	0.0087	0.0232	0.0233

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 4	0.001	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.50	49003.932	100.00
RUNOFF	0.932	2029.368	4.14
EVAPOTRANSPIRATION	20.474	44591.928	91.00
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 4	0.319644	696.169	1.42
AVG. HEAD ON TOP OF LAYER 4	0.0003		
PERC./LEAKAGE THROUGH LAYER 6	0.131245	285.845	0.58
CHANGE IN WATER STORAGE	0.963	2096.792	4.28
SOIL WATER AT START OF YEAR	37.084	80767.436	
SOIL WATER AT END OF YEAR	37.352	81351.697	
SNOW WATER AT START OF YEAR	0.802	1746.871	3.56
SNOW WATER AT END OF YEAR	1.497	3259.403	6.65
ANNUAL WATER BUDGET BALANCE	0.0000	-0.001	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.29	1.30	0.99	1.13	2.11	2.27
	1.20	2.31	1.84	0.81	0.81	1.41
STD. DEVIATIONS	0.65	0.29	0.38	0.67	1.46	1.48
	0.89	1.89	1.66	0.68	0.29	0.53
RUNOFF						
TOTALS	0.000	0.000	0.523	0.516	0.017	0.003
	0.000	0.018	0.025	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.399	0.637	0.051	0.009
	0.000	0.048	0.058	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.478	0.460	0.582	1.058	1.744	2.382
	4.407	2.481	0.975	0.529	0.392	0.419
STD. DEVIATIONS	0.080	0.071	0.125	0.345	0.647	0.660
	1.060	1.280	0.671	0.204	0.130	0.068
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0205	0.0162	0.0167	0.0157	0.0143	0.0130
	0.0120	0.0115	0.0440	0.0360	0.0267	0.0235
STD. DEVIATIONS	0.0422	0.0324	0.0307	0.0261	0.0239	0.0210
	0.0199	0.0182	0.1102	0.0933	0.0649	0.0518
PERCOLATION/LEAKAGE THROUGH LAYER 6						
TOTALS	0.0021	0.0016	0.0016	0.0017	0.0018	0.0015
	0.0022	0.0020	0.0018	0.0024	0.0035	0.0032
STD. DEVIATIONS	0.0052	0.0033	0.0032	0.0031	0.0029	0.0022
	0.0033	0.0028	0.0025	0.0034	0.0074	0.0072

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001
	0.0001	0.0001	0.0005	0.0004	0.0003	0.0003
STD. DEVIATIONS	0.0005	0.0004	0.0003	0.0003	0.0003	0.0002
	0.0002	0.0002	0.0013	0.0010	0.0007	0.0006

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 10

	INCHES		CU. FEET	PERCENT
PRECIPITATION	17.47	(3.114)	38057.5	100.00
RUNOFF	1.103	(0.4967)	2401.82	6.311
EVAPOTRANSPIRATION	15.906	(1.9757)	34642.41	91.026
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.00000	(0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.25000	(0.38738)	544.482	1.43068
AVERAGE HEAD ON TOP OF LAYER 4	0.000	(0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.02528	(0.04137)	55.058	0.14467
CHANGE IN WATER STORAGE	0.440	(2.0690)	958.26	2.518

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 10 and their dates (DDDYYYY

	(INCHES)	(CU. FT.)	
PRECIPITATION	2.64	5749.79468	2210009
RUNOFF	0.732	1593.41805	840002
DRAINAGE COLLECTED FROM LAYER 3	0.00000	0.00000	2590008
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.013872	30.21165	2590008
AVERAGE HEAD ON TOP OF LAYER 4	0.005		
MAXIMUM HEAD ON TOP OF LAYER 4	0.000		
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET		
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000849	1.84829	3650010

SNOW WATER	4.81	10468.4806	700004

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4030
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1332

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 10

LAYER	(INCHES)	(VOL/VOL)
1	1.4998	0.2500
2	11.6838	0.2434
3	1.2372	0.0687
4	0.5244	0.4370
5	1.6064	0.1339
6	20.8007	0.1156
SNOW WATER	1.497	

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